Evaluating future-tensed sentences in changing contexts

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Abstract According to the actualist view, what is essential in the truth conditions of a future-tensed sentence of type 'it will be the case that φ' is the reference to the unique course of events that *will become actual*. On the other hand, the modal view has it that the truth conditions of such a sentence require the truth of φ being already "settled" at the time of utterance, where "being settled" is defined by universal quantification over a domain of courses of events, the futures compatible with what has happened up to the time of utterance. On the proposal we discuss in this paper, actualism and modalism are seen as two related attitudes that speakers can have when evaluating future-tensed sentences, and the corresponding interpretations undergo a unified semantic treatment based on a contextual notion of settledness. A central feature of our approach is a dynamic view of contexts of utterance, according to which the world of the utterance is not fixed once and for all, as different worlds, by the passing of time, can play this role in turn. Finally, one major goal of the paper is to show how the unified analysis we propose accounts for a particularly interesting interpretation of future-tensed sentences, often referred to as 'epistemic reading'.

"Par nature, le monde des possibles m'a toujours été plus ouvert que celui de la contingence réelle." Marcel Proust, *La Prisonnière*.

1. Introduction

There can be different reasons for evaluating a future-tensed sentence of type 'It will be the case that φ' (hereafter, a *future sentence*) as true or false. Essentially, they can be gathered in two main families.

(i) A future sentence can be evaluated as true on the basis of certain evidence *now* available, represented by a relevant background of information. For example, suppose that on January 24th, 2008 someone asks you whether it is true that the next Olympic Games will take place in China. Having already consulted the official website of the International Olympic Committee, as well as a number of credited newspapers, you answer by uttering (1a):

(1) a. The next Olympic Games will take place in China.

The claim, here, is that your answer is *true* at the utterance time, whilst, had you responded by uttering (1b), your answer would have been simply *false*.[1]

(1) b. The next Olympic Games will take place in Japan.

In this context, the future sentence (1a) is roughly equivalent to the modal sentence (1c):

(1) c. (According to the official plans) the next Olympic Games must take place in China.

where both the modal content and the relevant background of information are made explicit by linguistic means.[2]

[1] On January 24th, 2008, to the question 'Is it true that the next Olympic Games will take place in China?', any well informed person would reply with a firm 'Yes, it is true!'. It is the kind of pre-theoretical intuition concerning truth which underlies this reply that we intend to account for. In this sense, what turns out to be true at a given time may turn out to be false at a later time. As remarked by B. de Cornulier (p.c.), the French sentence 'Marcel ne partira plus demain' (lit. *Marcel not leave (fut) any longer tomorrow*) sounds quite natural and true in a context in which it *was* true that Marcel would leave tomorrow, whilst it is *no longer* true that he will.

[2] Sources of information of a different kind are involved in the examples we will discuss in the next sections. A typical case is the use of future sentences to report other people's *plans*, *intentions* or *deliberations*.

(ii) Alternatively, a future sentence can be considered true because the event it reports occurs as a *real* fact at some time in the future. Suppose that you throw a die, uttering (2) at the same time:

(2) The die will come up six.

Suppose further that it is common knowledge that the die has not been loaded. In this case, the claim is that sentence (2) is neither true nor false *at the time of utterance*. There is no present evidence (either facts, or plans, or yet other information) which may already settle the issue of the die coming up six. Given the present indeterminacy of the matter, it may be that the die comes up six, and it may as well be that it doesn't. The only way to pin down a truth value for the sentence is by *waiting and seeing* whether the reported event turns out to occur or not. The intuitive difference between this case and the previous ones is that (1a,b) already have a truth value at the time of utterance, whilst (2) cannot be regarded as having any truth value then, but it *gains* one only when the reported event occurs (or when it has no chance to occur anymore).

Given the above difference between (1a, b) and (2), one may assume that this is symptomatic of two different interpretations of the future tense. On the one hand, examples (1a,b) should attest a *modal* interpretation, according to which what is relevant for determining the truth value of 'Fut(φ)' is how things are in the states of affairs compatible with the present evidence (e. g. a background of *planned* actions), so that the truth (or falsehood) of the sentence is already settled at the utterance time. On the other hand, example (2) should attest a *temporal* interpretation, according to which what is relevant for determining the truth value of 'Fut(φ)' is how things turn out to be at some future moment: making the truth (or falsehood) of 'Fut(φ)' settled is a task which is remitted to the time flow.

Faced with these two allegedly different interpretations, our main goal will be to provide a *unified* semantic treatment that accounts for both, and to frame it within a standard non-relativistic semantics.[3] The paper is organized as follows. In section 2 we address some problems of empirical adequacy raised by what we call *Symmetry Assumption*, according to which the future is the mirror image of the past. A further problem for this assumption is considered in section 3, in connection with the so-called Multiple Choice Paradox. To pave the way for an account of this paradox, we introduce a *Dissymmetry Assumption*, which we formulate within a Branching Time (BT) framework. In section 4 we tackle some difficulties that arise as soon as one tries to represent the world of the utterance within a BT framework, and propose a dynamic characterization of the utterance world as a time-dependent feature of the context. Exploiting such dynamic view of actuality, in section 5 we show how, as time goes by, the same utterance comes to be associated to different contexts. In section 6 both families of interpretations of future sentences, actualism and modalism, undergo a unified semantic treatment. Finally, section 7 is devoted to showing how this treatment deals with the epistemic reading of future sentences.

2. The future as the mirror image of the past

The term 'factivity' is often used to characterize the behaviour of certain logical operators (and, by extension, of the natural language constructions whose translations make use of those operators). In the relevant sense, the operator '*Op*' is factive if, for any sentence φ, the truth of '*Op*φ' entails the truth of φ.

It is straightforward to recognize that, if past and future tenses are translated as the Priorean operators '*P*' ('it was the case that') and '*F*' ('it will be the case that'), they cannot be considered factive *tout court*: of course, the truth at time *t* of 'it was (will be) the case that φ' does not entail the truth at *t* of φ.

[3] For a recent proposal of a relativistic semantics, worked out to deal with future contingent statements, see MacFarlane (2007). See also MacFarlane (2003).

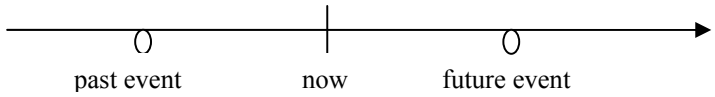
However, a notion of "shifted" factivity could be invoked in these cases. In particular, one could associate the past tense to "backward factivity", that is to the idea that the truth of '*P*φ' at *t* entails the truth of φ at a time *s* preceding *t*; symmetrically, one could associate the future tense to "forward factivity", i.e. to the idea that the truth of '*F*φ' at *t* entails the truth of φ at a time *s* following *t*. The requirement of backward/forward factivity is made explicit in the classical truth conditions for past and future sentences:

(3) $[\![P\varphi]\!]^{M,t} = 1$ *iff* there is a time t' such that $t' < t$ and $[\![\varphi]\!]^{M,t'} = 1$

(4) $[\![F\varphi]\!]^{M,t} = 1$ *iff* there is a time t' such that $t' > t$ and $[\![\varphi]\!]^{M,t'} = 1$[4]

Semantic clause (4) is obtained from (3) by a simple inversion of the time direction. To use a metaphor exploited by Prior, we could say that the semantic representation of the future is here the *mirror image* of the semantic representation of the past: the former is perfectly symmetrical with respect to the latter. We call this view *Symmetry Assumption*.
This symmetrical conception is accompanied by the familiar way of representing the time flow: an oriented line which stands for a single course of events, i. e. for the world where the utterance event occurs; along this line, events are located before or after a given point, which is the utterance time (= now) in the simplest cases.

Fig. 1



One could expect this kind of representation to be particularly appropriate at least for those natural languages in which the future tense is syntactically realized not as a modal auxiliary (as in English and German), but as a simple flectional form in the same way as the past tense (as in Romance languages)**.** Indeed, for such languages a purely temporal interpretation of the future tense could be expected as the most natural. Yet, it is easy to verify that this expectation is not borne out by the facts. Even in languages with a flectional future tense, there are well-attested uses of this tense that must be characterized in terms of *modal*, rather than *temporal*, notions. Here are some examples from Italian.

Epistemic use

There is someone knocking at my door, and I say:

(5) Sarà Leo.
(it) be [fut, 3sg] Leo
'That will be Leo'

Law-like statements

At the elementary logic exam, when asked about the relation of identity, a student replies by uttering (6):

(6) La relazione di identità varrà solo fra un individuo *a* e *a* stesso.
the relation of identity hold [fut, 3sg] only between an individual *a* and *a* itself
'The identity relation will only hold between an individual *a* and *a* itself'[5]

[4] $[\![\alpha]\!]^{M,t}$ is the denotation of the expression α relative to model M and time *t*.
[5] The modal use of the future tense exemplified by (6) is similar to the one illustrated by the English sentence reported below (this is a remark taken from Fleischman (1982), which ironically concerns the English future itself).

Performative use

Sentence (7), a passage from a previous Italian version of this paper, shows what may be labeled 'performative use of the future'.

(7) Chiameremo *fattività in avanti* questa proprietà.
call [fut, 1pl] *factivity in forward* this property
'We will call this property *forward factivity*'

Concessive use

Sentence (8) below is a translation in Italian of a comment made by the editor who rejected Proust's *Recherche*. This sentence may be taken to illustrate a concessive use of the future.

(8) Sarò forse duro di comprendonio, ma non riesco proprio a capire come un signore possa impiegare trenta pagine per descrivere come prende sonno.
be [fut, 1sg] maybe hard of understanding, etc
'I may even be dull-witted, but I just can't understand how a gentleman needs thirty pages to describe how he gets to sleep'

For no one of the sentences (5)-(8)[6] can forward factivity be taken as constitutive of its truth conditions. For example, it is clearly not relevant to the truth conditions of (5) that Leo be at my door at some time following the time of my utterance, as the sentence is rather interpreted as expressing a supposition with regard to the time of utterance. Even more strikingly, the fact that the identity relation holds between *a* and *a* itself at some future time does not exhaust the truth conditions of (6), which is rather interpreted as an omnitemporal statement. Notice that the truth conditional irrelevance of forward factivity for the Italian examples (5)-(7) extends to the corresponding sentences of English (reported above as their translations).
To sum up, these data cast doubt on the idea that forward factivity should be taken as a necessary condition for the truth of future sentences. Sentences (1a, b) from sect. 1 could be used to make the same point, as we saw that they have a truth-value fixed at the utterance time *t* uniquely on the ground of facts holding at *t*.

3. The Multiple Choice Paradox and the condition of settledness

3.1 The paradox

The examples from the previous section show that future sentences can be used to express different flavours of modality, and that an analysis of their truth conditions uniquely in terms of forward factivity is likely to be not empirically adequate.[7] Further evidence for this inadequacy comes from what we call 'Multiple Choice Paradox' (MCP).[8] This was first considered by Prior (1957), who

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(i) Future as a grammatical category will involve temporality, aspect and modality. The more modal (or aspectual) a form becomes, the less temporal it will be, and *vice versa*.

[6] Examples of this kind are not marginal cases. See Bertinetto (1986) and Berretta (1994) for further documentary evidence about Italian.

[7] That the English future tense can convey modal meanings is well-known, and is naturally related to the fact that the future auxiliary 'will' derives from a modal verb. Some researchers have argued that 'will' is actually not a tense, but a modal auxiliary. Yet others have argued that 'will' is semantically ambiguous between the interpretation of a tense and that of a modal. It may be at first surprising that even in a language like Italian, where the future tense is realized as a bound morpheme, future-tensed sentences can display so many modal meanings. However, the modal aspects of the Italian future tense are no longer surprising if one considers the diachronic development from the late Latin periphrasis 'cantare *habeo*' (*I have to sing*) through the Old Italian 'cantare *ao*' to the current form 'canterò' (see Fleischman 1982 for details about this process).

[8] We use this term because the argument that we consider here after Prior (1957) can be seen as a future-tensed version of the Multiple Choice Paradox discussed in Bonomi (1997) in relation to the progressive aspect.

argued on its basis in favour of stronger truth conditions than those based on forward factivity. Here is the passage where he presents the argument:

> Suppose A and B are being pushed towards the edge of a cliff, and there will be no stopping this process until there is only room for one of them. Then we may be able to say truly that it will definitely be the case that A or B will fall over, even though we cannot say truly either that A will definitely fall over or that B will definitely fall over. (Prior, 1957: 85)

Prior's paradox is that sentence (9a) below is definitely true in the described circumstances, whilst neither one of (9b, c) is definitely true.

(9) a. It will be the case that A or B fall over.
    b. It will be the case that A falls over.
    c. It will be the case that B falls over.

To account for this paradox, Prior suggests that the future sentence 'it will be the case that φ' is true at time *t* if and only if there are facts at *t* that make the truth of φ at a future time already *settled* at *t*. This can be made explicit by referring to possible courses of events that are all alike with respect to past and present events, while differing from each other with respect to the future (in other terms, courses of events that are compatible with the state of the world at *t*). The above truth conditions can be restated thus:

'It will be the case that φ' is true at time *t iff* φ turns out to be true in all the courses of events that are compatible with the state of the world at *t* at some time following *t*.

In the Priorean example, that A or B will fall over is not settled at the beginning of the pushing process, but it *becomes* settled at some later point. When it becomes so settled, sentence (9a) becomes true, whereas each one of (9b,c) may still be not true then, insofar as it is not yet settled which of A or B will fall over. This explains how it is possible that (9a) is true while neither one of (9b,c) is true.
However, can we consider Priorean settledness a plausible requirement for the semantic contribution of the future tense in everyday discourse? To be sure, there seem to be special situations in which the existence of present and past facts makes the truth of a future sentence settled in the Priorean sense. For example, if I say:

(10) Within a fortnight, it will be Leo's birthday.

the fact that today is April 8th and that Leo was born on April 23rd makes (10) *definitely* true at the utterance time (on the Priorean account sketched above, one can say that Leo's birthday occurs on April 23rd in *every* course of events compatible with the current state of the world). However, for most future sentences in ordinary discourse, there are no present facts which are sufficient to make the future occurrence of the relevant event *already* settled at the present time. Consider Prior's example again. The definite truth of (9a) in the envisaged scenario is explained by resorting to the existence of facts that are supposed to *settle* the issue. Yet, how can we rule out the possibility that some unexpected event will prevent both A and B from reaching the edge of the cliff? For example, an earthquake might destroy the cliff before the event of pushing is completed. Objections of this sort can be raised whenever a *contingent* event is concerned. With few, if any, exceptions, it seems then that future sentences will wind up untrue, if *objective* (metaphysical or historical) settledness is assumed as a necessary condition for their truth.[9]

[9] We use the adjective 'historical' in the sense made precise by Thomason (1984). In his T×W approach, Thomason defines the set of historical alternatives through *t* for a given world *w*, formally represented as $\{w': w' \approx_t w\}$, as the set of those worlds which share the same past as *w* up to and including *t*, while differing from *w* only in what is future to *t*.

3.2 From objective to contextual settledness

In the light of what has just been said, the problem we must address is how to characterize the notion of settledness to make it relevant to the truth conditions of future sentences. We tackle this issue as follows. Instead of considering the totality of past and present facts, and all the future possibilities compatible with them, we consider the facts in light of some background assumptions which hold in the context of utterance, and select only the future possibilities that are compatible with (the ideal norm established through) the assumptions themselves. The kind of necessity that settledness incorporates is interpreted accordingly: being settled means to be true in all the courses of events that are compatible with the background assumptions. Let us call the revised notion of settledness 'contextual settledness'.

To see the relevance of this notion in a particular case, consider the following example. Imagine that the Cabinet Council has just decided that, during his next visit to Tuscany, the Prime Minister will visit Montepulciano or Montalcino to open a wine fair. Due to the rivalry between the two towns in the wine business, it was impossible, at the moment, to decide *which* of them would receive the Prime Minister as honour guest. So, when asked about the Prime Minister's plans, the official spokesman answers by uttering (11a):

(11) a. Prodi will visit Montepulciano or Montalcino.

In view of the decision made by the Cabinet Council, and assuming that nothing in the present state of the world makes a future visit by Prodi to either one of the two towns impossible, we consider what the spokesman has said *true* at the time of utterance t_u. Like in the Olympic Games example from sect. 1, the truth of the statement is determined on the ground of information which is available at t_u, i.e. the information codified in the minutes of the meeting. So, although there certainly are possible futures at t_u on which the planned visit does not take place, once the relevant decision is taken into account, such futures bearing no visit are exempted from consideration as they are not compatible with the ideal norm established through the decision.
We further note that this example provides an instance of MCP. Indeed, which town will eventually be chosen is still an open issue, therefore (11a) entails neither of the following statements:

(11) b. Prodi will visit Montepulciano.
c. Prodi will visit Montalcino.

To sum up, the previous discussion has highlighted the need for a conceptual shift: from Priorean objective settledness to a semantically more relevant notion of contextual settledness. The former, we saw, is defined in terms of truth in all the possible courses of events which are compatible with the actual state of the world. The latter is defined in terms of truth in the possible courses of events which are compatible both with the actual state of the world and with a background of information. The motivation for the shift is this: Priorean settledness presumably commits us to a huge set of alternative courses of events, many of which are not relevant for the evaluation of future sentences; contextual settledness, on the other hand, requires that a much more restricted set of alternatives be considered, which contains only those possible courses of events that conform to the truth of certain contextual assumptions. Most of the future sentences that we are willing to accept as true have a chance to come out true only if contextual settledness is assumed. For these reasons, our semantical approach will be based on contextual settledness; accordingly, a future sentence will be evaluated with respect to a given world *and* a given (possibly empty)[10] set of assumptions.

[10] In some cases, there are no assumptions which may restrict the future possibilities of the world of evaluation, so that contextual settledness just reduces to Priorean settledness. This happens, for instance, when an utterance of 'the die will come up six' is evaluated in a context like that described in section 1. Intuitively, in that case we just consider the whole range of historical possibilities, which includes both futures in which the die comes up six and futures in which it doesn't, and this explains the fact that the utterance is evaluated as neither true nor false.

We emphasize since now that the semantic role of the contextual assumptions is *to restrict the world of evaluation*: to evaluate a sentence relative to a world *and* a set of assumptions (or background of information) is to evaluate it relative to a "restricted world".

3.3 The Dissymmetry Assumption

We will now consider a major consequence of MCP. What we need is a framework in which the truth of (11a) does not entail the truth of either one of (11b, c). Yet, if we look *only* at a *single* course of events (as in Fig. 1 above), there is no plausible way to get this result. Under the assumption that (11a) is true in the unique course of events, it follows that either (11b) or (11c) is also true there. To avoid this conclusion, it seems that one should refer to a *plurality* of courses of events in the future of a given moment (in the case at hand, these courses of events would correspond to the alternative futures compatible with what has been decided by the Cabinet Council) and look at what happens in all these "worlds": in some of them Prodi visits Montepulciano, in others he visits Montalcino.

What emerges from considering MCP is a dissymmetry between the way the past and the future are represented in language. As a matter of fact, the "Priorean" argument developed for (11) does not hold any longer if we change the temporal orientation from the future to the past. In other terms, MCP vanishes if the future tense is replaced by the past tense. This can be shown by considering the sentences in (12):

(12) a. Prodi visited Montepulciano or Montalcino.
b. Prodi visited Montepulciano.
c. Prodi visited Montalcino.

Intuitively, if (12a) is true now, then either (12b) or (12c) must also be true now. Indeed, the present truth of (12a) can only be related to the occurrence in the past of (at least) one of the following events: (a) a visit by Prodi to Montepulciano, (b) a visit by Prodi to Montalcino. If it was the first to occur, sentence (12b) is now true; if the second, sentence (12c) is now true.

Further evidence for the relevance of the dissymmetry between past and future is provided by the examples given below**.** Consider the contrast between (13a) and (13b):

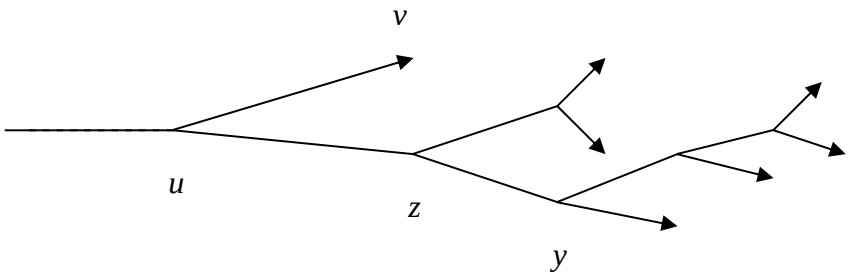
(13) a. Next week Prodi will visit Tuscany. But in an emergency, his visit will be cancelled.
b. ? Last week Prodi visited Tuscany. But in an emergency, his visit was cancelled.

It is not difficult to imagine a situation in which (13a) would be perfectly acceptable. Suppose that, as in the context described above, the Cabinet Council has just decided that the Prime Minister will visit Tuscany. Suppose further that, although the crisis in Kosovo is now under control, a sudden worsening cannot completely be ruled out. In this context, the official spokesman utters (13a) to answer a question about Prodi's next engagements. His specification in the second part of the discourse is to be understood in connection with the situation in Kosovo. The intuition is that (13a) is acceptable and true in the situation just described. However, there is *no* plausible situation in which (13b) would turn out to be consistent.

A reasonable explanation for the contrast between the two discourses is based on a kind of "context shift". When she evaluates the first sentence of (13a), the hearer considers a restricted set of future courses of events, those which are most likely in light of the contextual assumptions. However, when she comes to the second sentence of (13a) and processes the phrase 'in an emergency', she shifts to a different set of courses of events, ones in which the unlikely event of an emergency has occurred, and evaluates the sentence 'his visit will be cancelled' relative to this shifted domain. The hypothesized change in the domain of future courses of events explains how it is possible for the second sentence of (13a) not to contradict the first. In the case of the past-tensed discourse (13b), such a mechanism of context shift cannot apply, because there is only one course of events relevant to evaluating past-tensed sentences. If it turns out that Prodi visited Tuscany in the unique past, then it cannot possibly be that his visit was cancelled. That is why (13b) turns out to be inconsistent.

These data suggest that there is something wrong with the Symmetry Assumption, and that it had better be rejected. On the view we are going to advocate, the past and the future of any moment *m* are structurally asymmetric: while the past of *m* is a single course of events, in which every event has been already actualized and is thus temporally related to every other event in the past (either by preceding or by following it), the future of *m* consists of many courses of events, the events on each course being temporally unrelated to the events on every other. We call this view *Dissymmetry Assumption*. This can be formally represented by taking moments in the past of *m* to be linearly ordered, and by assuming that the linear order does not hold for moments in the future of *m*. The structural difference between the past and the future can be depicted as in Figure 2 (the time direction is represented by the spatial orientation of the arrowed lines).

Fig.2



This kind of formal representation characterizes the so-called Branching Time (BT) framework, which we will adopt for our semantical purposes in the ensuing sections.

4. Time-dependent actuality

We have replaced the Symmetry Assumption with a different option, according to which time is linear towards the past and branching towards the future. Since our main goal will be to give a formal definition of *truth in context*, we need to make sense of the notion of actuality in the precise semantic sense we will be concerned with, according to which 'actual world' essentially means 'utterance world', or, more explicitly, 'world of the context of utterance'.[11]

If one accepts (as we do here) the idea that the future is open and that, as a consequence, an utterance event can be located in different courses of events, one must admit that a context as such is unable to select one of these as *the* future of the utterance event (whilst it is perfectly able to select a particular person as *the* agent of that event).[12] In other words, the issue whether an utterance event belongs to a certain temporally complete course of events (one that includes a future segment as well as a past one) is *underdetermined* from the point of view of what the context of utterance can

[11] See Kaplan 1989.

[12] This is not a problem for an indexical analysis of actuality like Lewis' (1983), according to which among the possible temporally complete courses of events**,** there is exactly one where *we* are located and where *our* utterances take place. This is what *we* call 'the actual world' (see Lewis 1983: 18-20). On this view, since an utterance event *e***,** occurring at time *t***,** is *uniquely* located in some particular course of events *w***,** and *w* is a temporally *complete* world (with a wholly specified past and a wholly specified future), it is possible to refer to a certain segment of world *w* as *the* future of *e*: this will be the segment of *w* including all the events of *w* which occur later than *t*. And only the future of *e* will be relevant for evaluating a future sentence at *t*. In general, the world *w* of the utterance event *e* may be referred to by *indexical* terms like 'the actual world', 'the actual course of events' (uttered in contexts having *w* as their world coordinate)**,** and the future of *e* may be referred to by indexical definite descriptions like 'the actual future' (uttered in contexts having *w* as their world coordinate and *t* as their time coordinate). And since "*our* future" is just a segment of the actual course of events, an utterance (in *w*, at *t*) of the sentence 'Fφ' might be interpreted as 'It will *actually* be the case that φ'. In this case there is no need to refer to a plurality of courses of events (unless some explicit modal operator is present). Obviously, the assumptions underlying this view are not compatible with Branching Time, so we need to propose an alternative characterization of the utterance world.

possibly specify.[13] From the indeterminist perspective that we adopt here, given any state of the world *u*, it does not make sense to use expressions like '*the* future of *u*' to denote a particular course of events among the possible futures at *u*. By the same token, there is no temporally complete course of events that can be designated by indexical expressions like '*the* actual world', '*the* world to which the utterance belongs', and so on.

Thus, the situation we face is characterized by a tension between the following theoretical points:

(i) On the one hand, due to the indeterminacy of the future, if a sentence is uttered at *u*, the utterance world cannot be identified with a *single* temporally complete course of events passing through *u*;

(ii) on the other hand, we still need to talk about the world of an utterance in order to sensibly talk of the truth of a sentence in a given context.

How to eliminate the apparent tension between (i) and (ii)?

To answer this question, we will take advantage of the *double nature* of moments in BT structures. Moments encode not only temporal information, but also modal information (indeed, any two moments lying on different branches can be assimilated to alternative world states).

As a preliminary step, we will start from a general notion of world which is compatible with the BT framework. We will adopt a *pluralistic* view: because of the indeterminacy of the events in the future of a moment *u*, we will conceive of the world at *u* as the particular subtree branching after *u* but linearly ordered up to *u*, i. e. as a cluster of temporally complete courses of events[14] containing a single past but many possible futures stemming from *u*.[15] Since a unique subtree of this kind can be associated to *u*, we can even identify a moment *u* with a world in this sense, that is as the cluster of courses of events which coincide up to *u* and diverge after *u*. That is why, from now on, we will speak of *moments* in the tree as *worlds*.

Take now an utterance event occurring at *u*. In the sense we have just clarified, the utterance world can be identified with *u* itself. This is shown in Fig. 3 below, where the thicker line stands for the segment on which actual events are located.[16] According to this type of representation, being actual with respect to a moment *u* means being in the present or in the past of *u*, i. e. occurring at some moment in the "trunk" of the corresponding subtree. Thus, for any branching point *u*, we have a domain of actual events which are located before the branching, and a domain of possible (but not actual) events located on the different branches.

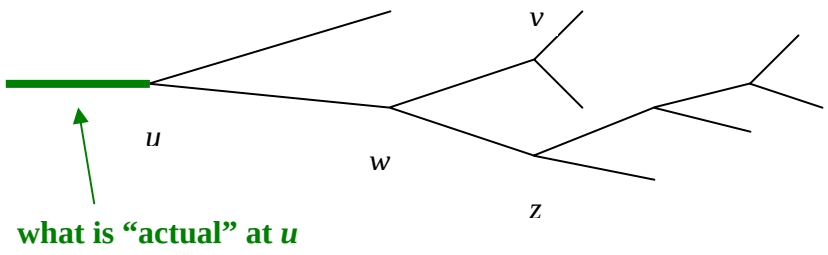
[13] This point is the same as Belnap, Perloff and Xu (2001) make in claiming that the context of utterance cannot initialize a history parameter.

[14] From now on, and from a technical point of view, the terms 'world' and 'course of events' will have distinct meanings: a world, in the sense clarified in the main text, can be represented by a moment u seen as the set of courses of events passing through u; a course of events, on the other hand, cannot be represented by any single moment, but rather corresponds to a complete linear path in the tree of branching time.

[15] For a similar characterization of BT worlds, see Belnap, Perloff and Xu (2001: 139-141).

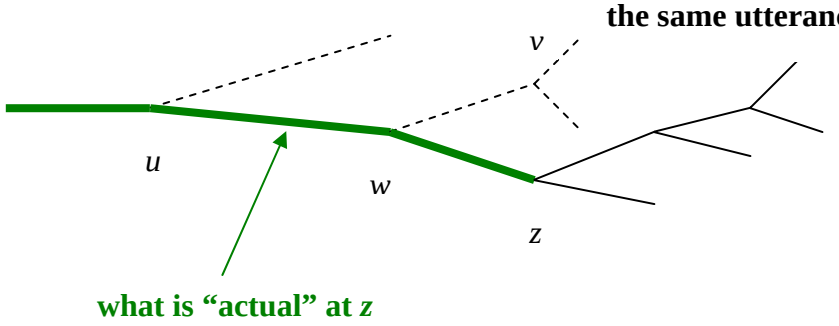
[16] See McCall (1976: 342) for a similar idea: 'We thus have not one but many universe-pictures, each one being a complete state-description of the universe at a time. Every picture has the form of a tree [...] the trunk containing all past and present events (relative to the time in question), and the branches representing all physically possible courses of future events. [...] All branches are equally real, and nothing indicates which branch will eventually form part of the trunk in a later universe-picture. The universe (at each time) is the whole tree; trunk and branches together.'

Fig. 3 **the "utterance world" *u***



As time goes by, the domain of actual events grows up and different clusters of courses of events come to correspond to subsequent moments, as illustrated in Fig. 4 (the dotted lines represent courses of events which are no longer possible from the point of view of *z*).

Fig. 4 **the "utterance world" *z* (for the same utterance)**



We will say that world *z* in Fig. 4 is a *temporal development* of world *u* in Fig. 3. But what about the utterance event at issue? In the framework adopted here, since this event is actual at *u*, it is *still* actual at any temporal development of *u*.
Let us say that an event *e belongs* to world *v* (or is actual at world *v*) if *e* occurs at some moment *u* such that $u \leq v$ (i. e. if *u* lies in the trunk of *v*). Thus, in general, the actuality of any event is preserved across the time flow, as stated by this obvious *Principle of Persistence*:

(PP) For any event *e* and for any moments *u* and *v*: if *e* belongs to world *u* and $u \leq v$, then *e* belongs to world *v* as well.

As an illustration of this point, consider the event of Queen Elisabeth's birth. That she was born at some place at a given time was true 24 hours ago, is true now and will be true 24 hours from now. In other terms, the event of her birth is part of the world as it was 24 hours ago, as it is now and as it will be 24 hour from now. And the same can be said of any utterance event. Thus, whilst the moment corresponding to the utterance time remains fixed, *different* moments (e. g. *u* itself, or *w*, or *z*, and so on) can play the role of the utterance world. Crucially, since principle (PP) guarantees that the utterance event (with the agent, the place, and the time of that event) is actual not only at *u*, but at any *v* such that $u \leq v$, the standard definition of context[17] can be adapted to the present framework in order to derive the Conservativity Principle (CP) given below.

Contexts (provisional definition)

Let a context for an utterance event *e* be a quadruple <*x*, *p*, *t*, *u*> such that *u* is a world to which *e* belongs, and *x*, *p* and *t* are the speaker, the place and the time of *e*, respectively.[18]

[17] See clause 10 from the definition of LD Structures in Kaplan (1989: 543-544).
[18] From this definition, it follows that *x* must be located at position *p* at time *t* in world *u*.

Given this definition, it is immediate to see that (PP) entails (CP):[19]

(CP) If *e* is an utterance event and c is a context for *e*, then c' is a context for *e* as well, where c differs from c' at most in its world coordinate, and $c_w \leq c'_w$.

That is, if in a context for an utterance event *e* the world of the context c_w is replaced by any temporal development of c_w, while keeping everything else unchanged, what we obtain is still a context for *e*. This fact will play an important role in the analysis developed in the next sections, which is based on a "dynamic" notion of context, since many different contexts are associated to the same utterance.

To sum up, on this proposal the moments in a BT structure have a *double* role to play, according to whether we consider the tree on which they are arranged (i) on the vertical axis or (ii) on the horizontal axis.

(i) As we have just remarked, on the vertical axis a moment *u* can be seen as a point which is alternative to other points in a *logical* space (for example, in Fig. 4 above *v* and *z* are *alternative* developments of *u*). Each of these points has a single past and many futures, so that it can be uniquely associated to a cluster of courses of events: the courses of events that coincide up to that point and diverge starting from it. It is in this pluralistic sense that we refer to moment *u* as a world.

(ii) However, on the horizontal axis a moment is also associated to *temporal* information, and can accordingly be seen as a particular time (for instance, we can say that moment *u* is earlier than moment *z*). This characteristic can be made explicit by defining an *instant* as an equivalence class of moments, such that each moment in U belongs to exactly one instant and, for any instant *i* and course of events *h*, $i \cap h$ has exactly one member. Moreover, instants preserve historical order.[20] In this sense, *v* and *z* may turn out to be located at the same time (i.e., at the same instant), even though they are different moments.[21]

This double nature of moments will be mirrored by our semantics. Ignoring other features that are not relevant for our purposes, we can define contexts as triples <*u*, *v*, X>**,** where *u* and *v* are moments, and X is a set of propositions (background of information). In a context <*u*, *v*, X>, moments *u*, *v* play distinct roles: *u* plays the role of the utterance time, in virtue of its being univocally associated with the time instant i_u, whereas *v* plays the role of the utterance world, in virtue of its being univocally associated with a cluster of courses of events. A particular case of context is given by triples <*u*, *u*, X> where the *same* moment *u* plays both roles.

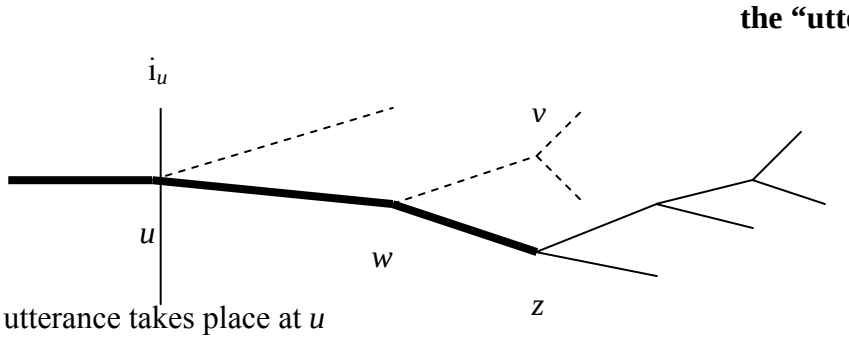
To grasp the intuition underlying this approach, suppose that a sentence S is uttered at moment *u* (on the background of certain assumptions X).

[19] In the formulation of (CP), c_w and c'_w are the world of context c and the world of context c', respectively.

[20] See Belnap, Perloff and Xu (2001: 195).

[21] The terms 'moment' and 'instant' have technical uses in this context. For our present purposes, the crucial point is that moments can be seen not only as times, but also as worlds (in the sense which has been made clear in the text).

Fig. 5



The utterance time is fixed once and for all, and is represented by *u* itself, as this moment corresponds to the unique time instant i_u. But what about "the world" of the utterance? Surely, *u* itself can be considered as a world (in the sense defined above) to which the utterance event belongs. In this case, the corresponding context will be <*u*, *u*, X>. Yet, we have just seen that, as time goes by, other worlds become eligible to play the role of the utterance world: for example world *w* (because the utterance event at issue belongs to this world, too) and, later, world *z*. In the former case the corresponding context will be <*u*, *w*, X>, in the latter <*u*, *z*, X>.
To conclude this informal part, let us survey the main features characterizing our approach:

(i) A context is represented as a sequence of parameters**,** including the utterance time, the (an) utterance world, and a background of information;
(ii) a world is represented not by a single course of events, but by a moment *u*, *seen as a cluster of courses of events* (i. e. the cluster of courses of events passing through *u*);
(iii) the utterance time is uniquely fixed as (the instant of) the moment at which the utterance takes place;
(iv) the utterance world is *not* uniquely fixed **(**many different worlds can be associated with the same utterance);
(v) because of (iv), an utterance is associated not to a single context, but to a plurality of available contexts: for any utterance *e*, moment *u*, and set of propositions X such that *u* represents the utterance time and X is the set of relevant assumptions, the class of *available contexts* for *e* is the set of triples <*u*, *v*, X> such that $u \leq v$.

Our approach diverges from the traditional view with respect to (ii), (iv), and (v)**,** but it agrees with this view in keeping the notion of context unmodified, as specified in (i). On the other hand, it diverges from so-called relativistic approaches[22] because of (i) and (iv). Indeed, (iv) is a crucial characteristic of the proposal under discussion: even adopting a "pluralistic" notion of world, as stated in (ii), different worlds can be associated to the same utterance event.

5. Closed and open parameters

The usual characterization of the actual world as the world of the utterance can be endorsed in the theoretical framework adopted here. This is possible because we have identified a world with a cluster of courses of events. But there is a further peculiarity in the picture we have suggested: due to the time flow, different moments can *in turn* play the role of world of the utterance, so that for

[22] There are clear differences at least with respect to MacFarlane (2003). He introduces *two* types of context as relevant for semantics (the context of utterance and the context of assessment), whilst we admit of only one (the context of utterance, with a changing utterance world, so that different contexts can be associated to the same utterance event). Moreover, he lets truth-value gaps into the picture at the level of post-semantics (thanks to a refinement of the supervaluational technique), whereas on our account truth-value gaps occur at the level of semantics and supervaluations have no role to play (this is so because we treat 'will' as a modal auxiliary involving a partial function; see section 6.2). In MacFarlane (2003, 2007) 'will' has no semantic role to play of its own.

any utterance *e*, many different worlds of *e* will be admitted. This feature of our framework will make it appear a bit non standard, for it is part of the received wisdom to conceive the elements of contexts as fixed once and for all together with the utterance; from this point of view, one can sensibly speak of *the* agent, *the* place, *the* time, *the* world, and so on, of a given utterance. So, it is quite natural, at this point, to wonder whether there are other cases in which a parameter of the context can take on alternative values.

We believe that there are. Here is an example. Imagine that Mr. X, the computer engineer of your department, after realizing that a dangerous virus is lurking in the LAN of the Students Room, hangs a poster on a wall in this room, which bears the alert message (14):

(14) There is a dangerous virus in the LAN of this room. Your computer, here, might be attacked.

There is a sense in which the act of hanging the poster counts as an utterance: by hanging the poster, Mr. X utters the alert message (14), and 'hanging the poster' and 'uttering the alert message' are just two different descriptions of the same act. A proper part of this utterance is the utterance of the second sentence of (14), which contains an occurrence of the indexical pronoun 'your'. Given standard (Kaplanian) assumptions about indexicals, we face the question of what referent is assured for 'your' by the context of Mr. X's utterance. As soon as we analyze the hanging/utterance situation described above, we realize that some of the parameters defining utterance contexts get a definite value at the time of utterance (the agent is fixed as Mr. X, the place as the Students Room, and so on), but other parameters do not (in particular, the addressee is not fixed once and for all). We say that the former are "closed" parameters, whilst the latter are "open". For the second sentence in the poster to say *something true or false* at any time, there must be a person who reads it; and the truth (or falsehood) of the original utterance depends on *who* is the reader (for example, if the reader has a MacBook, which cannot be attacked by viruses, the utterance comes out false, if he has a PC the utterance comes out true, and if he has no computer at all, the utterance comes out neither true nor false).

In such cases, one might say that there are *different* contexts of use in correspondence with different addressees (the other contextual features remaining fixed), i.e. one has a new context *whenever* a person reads the poster. Notice that if a student reads the poster at the exact moment at which Mr. X hangs it on the wall (the utterance moment), this is not the end of the story: if other students read the poster later, other contexts come into being. To sum up: we would have here a *changing* context of utterance, depending on the *addressee* we are considering, that is a case in which a feature of the context (the addressee) is not univocally specified. Our suggestion is that something similar happens in the case of future sentences, where the *changing* context of utterance depends on the *world* in which the utterance can be located.

In general, open parameters can be defined as follows:

Open parameters

Let a context for a given utterance *e* be a sequence of parameters as defined above. We will say that *e* is associated to an open parameter π if there are contexts c and c' such that both c and c' are contexts for *e*, and $\pi_c \neq \pi_{c'}$.

In standard theories of context, only closed parameters are admitted, under the assumption: one utterance, one context. Yet, in the light of the definition above, different contexts can be associated to the same utterance in the presence of an open parameter. In example (13), the open parameter is that for the addressee,[23] while in the examples we have previously discussed the open parameter is the utterance world[24].

[23] At least if one admits that the act of hanging the poster counts as an utterance. One may not accept this assumption, and object that there is a different utterance (and a difference proposition expressed) for each reader. In this case, the similarity with the examples we discuss in the text would probably vanish. However, we reply to this objection by advocating a theory of utterances according to which these are events defined by three essential features, namely agent,

Phenomena of this kind have been known for a while in the semantic literature.[25] What is new in our proposal is the idea that the "open" parameters of contexts may include the world parameter.

6. A uniform semantic analysis

On the formal approach we are going to propose, the actualist and the modalist interpretation of future sentences are analyzed in a uniform way, without positing a semantic ambiguity in the future auxiliary 'will'. We reduce these two interpretations to two possible attitudes speakers can have when they deal with the future: (i) the "Wait and See" attitude, and (ii) the "Sic Stantibus Rebus" attitude. What is common to both interpretations is the notion of settledness, while the difference uniquely depends on the values of certain contextual parameters.

The actualist interpretation (Wait and See)

As we argued above, an answer to the question of which future will become actual is necessarily underspecified with respect to contextual information. Consequently, in order to make sense of the actualist intuition concerning the relevance of the unique future that will become reality, we reconstruct it in terms of a "wait and see" attitude, whose precept is: focus on the unique state of the world that happens to be actualized.[26] From this point of view, settledness only obtains at the crucial time at which the relevant event occurs (or has no chance to occur anymore). This fact accounts for the intuition that, on its actualist interpretation, a future contingent may have no truth-value before this crucial time, as in the die example in sect. 1.

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position, and time. This is a theory also advocated by Israel and Perry (1994). According to such a view, neither the addressee nor the world count as essential features of an utterance.

[24] The difference between the case of (13) and the cases of interest for us is that in the former the openness of the relevant parameter (the addressee) induces variability of the semantic value of a sentence constituent (the indexical 'your'), whilst in the latter the openness of the relevant parameter (the world) does not do that, insofar as there are no sentence constituents that are indexical on that parameter.

[25] See, on this point, the "attributive" reading of indexicals discussed in Nunberg (1993: 22), where the test that is proposed for attributive readings is 'being able to append the qualification *whoever that may be* or some such to the assertion'. In this connection, one might also say that, on our proposal, the Wait and See interpretation we will characterize in the next section might be associated to the "attributive" reading of the indexical expression 'the actual world' ('the utterance world'): It will be the case that $\phi \Rightarrow$ It will be the case that ϕ in the actual world, *whatever that may be*.
To account for examples like 'I am not here now' (i. e. a recorded message in an answering machine), Predelli (1998) resorts to a distinction between context of utterance and context of interpretation. This is close, of course, to MacFarlane's distinction between context of utterance and context of assessment mentioned above. In both cases, the notion of truth in context is based on a complex notion of context (context of utterance + context of interpretation/assessment). On our analysis, we have simple but variable contexts.

[26] This is the way we suggest to reconstruct the so-called Okhamist perspective (see Prior 1967). Indeed, actualism is based on the idea that 'what determines the truth of any statement of the form "it will be the case that *p*" is not whether *p* is true in some possible future, or in all, but whether *p* is true in *the actual* future. That is, in the branch that becomes history.' (McCall, 1979: 489). Thus, if you agree with indeterminism in rejecting the presupposition that there *is* such a branch, a plausible idea is 'that there is only one way to evaluate the truth or falsehood of a future contingent statement, namely by waiting and seeing.' (Ibid., 490.)

The modalist interpretation (Sic Stantibus Rebus)

Alternatively, in order to obtain the modalist interpretation, we stick to the *current* assumptions, and check whether the truth (or falsehood) of the statement at issue is *already* settled with respect to them. In this case, we do not endorse the "wait and see" attitude, as everything relevant for the truth evaluation is given by the state of information holding at the utterance time, as in the Olympic Games example in sect. 1.[27]

6.1 The formal framework

Let's now turn to the definition of Branching Time (BT) model.

A BT model is a 4-tuple $M = \langle U, \leq, D, F \rangle$ satisfying the following properties:

(a) U is a non empty set, the domain of moments;

(b) $\leq_U$ is a partial order over U (i.e., it is a reflexive, transitive, and anti-symmetrical relation over U); $\leq_U$ is forward branching but not backward branching (i.e., it is branching towards the future but not towards the past), which means that $\leq_U$ satisfies the following postulate:

Backward Linearity

(BL) $\forall m_0 \forall m_1 \forall m_2 [[m_0 \leq_U m_2 \wedge m_1 \leq_U m_2] \supset [m_0 \leq_U m_1 \vee m_1 \leq_U m_0]]$;

(c) D is a non empty set, the domain of individuals;

(d) F is a class of denotation functions mapping expressions of any syntactic category to their denotations relative to certain semantic parameters (we will say more about the functions in F below, after introducing worlds and contexts of utterance).

Histories (or courses of events) are maximal chain of moments.

Histories

A set $X \subseteq U$ is a history in U iff X satisfies the following conditions:

(i) $\forall m_0, m_1 \in X\ [m_0 \leq_U m_1 \vee m_1 \leq_U m_0]$

(ii) $\forall Y \subseteq U$, if $\forall m_0, m_1 \in Y\ [m_0 \leq_U m_1 \vee m_1 \leq_U m_0]$ and $X \subseteq Y$, then $X = Y$

The underlying intuition is that histories are temporally complete linear paths, each of which can be seen as a deterministic world. The concept of cluster of all histories passing through a given moment is very important in our semantics. Thus, for any $m \in U$, we define H_m as the set of all histories containing *m*. We note that the cluster of histories H_m is univocally determined by *m*. We will refer to such clusters as BT worlds**.**[28] A further concept which we need for semantical purposes is that of *(time) instant*. We need instants as entities representing purely temporal information connected with the location in time of a certain event. Instants will thus be the counterparts of time points of linear tense logic. Notice that moments are not suitable as such counterparts, since any moment is a concrete maximal event which has cotemporal alternatives (for instance, I am in Milan right now, but I might have been in Rome right now – only had I taken the train to Rome yesterday night), so that for making sense of a cotemporal alternative to a given moment we actually need a

[27] This is the way we reconstruct the so-called Peircean approach to the future (see Prior 1967)**.** See Burgess (1979: 575): 'if, like the Peirceans and unlike the Okhamists, one insists that every meaningful statement must have a truth-value which is independent on which possible future may in the end be actualized, *then* the only reasonable thing to say is that 'F*p*' is *true* when *every* possible future contains a moment of *p*'s truth, *false* when none and some third, middle, neuter truth-value otherwise.'

As will be clear from the formal framework, what distinguishes our analysis from more traditional reconstructions of the Peircean approach is the crucial role attributed to the relevant background of information in restricting the domain of admissible futures.

[28] BT worlds can be seen as indeterministic worlds. We adopt the notion of BT world as formal counterpart of the pre-theoretic notion of possible world. From now on, whenever we speak of worlds, we will mean BT worlds, not single histories.

higher order concept. We define the set of instants as a set of equivalence classes of moments (hence, a partition over U) such that each moment belongs to exactly one instant, and for any instant *i* and history *h*, $i \cap h$ has exactly one member. We define i_m as the instant to which the moment *m* belongs. Instants are understood as preserving historical order, in the sense defined below (we use 'i_j', 'h_j' as sorted variables ranging over instants and histories, respectively):

(ORD) $\forall i_0 \forall i_1 \forall h_0 \forall h_1 [h_0 \cap i_0 \leq_U h_0 \cap i_1 \rightarrow h_1 \cap i_0 \leq_U h_1 \cap i_1]$

We note that the partial order $\leq_U$ can be used to order instants in an obvious way:

$i_0 \leq i_1 =_{df} \exists m_0 \in i_0 \exists m_1 \in i_1 \; m_0 \leq_U m_1$

It is also obvious that instants can be temporally ordered with respect to moments on the basis of the same relation $\leq_U$, in the following way:

$i_0 \leq m_1 =_{df} \exists m_0 \in i_0 \; m_0 \leq_U m_1$
$m_0 \leq i_1 =_{df} \exists m_1 \in i_1 \; m_0 \leq_U m_1$[29]

We will make moments play *two* roles. If *m* is a moment at which a certain event *e* takes place, then *m* will represent both (a) the time of *e*, as *m* univocally determines the instant i_m, and (b) the world of *e*, as *m* also univocally determines the BT-world H_m. Accordingly, we will assign moments as values to time parameters and world parameters as well. Keep in mind that whenever a moment *m* is taken as the value of a time parameter, *m* is proxy for i_m, and whenever *m* is taken as the value of a world parameter, *m* is proxy for H_m.

For our purposes, we will represent a context c as a triple consisting of a time t_c, a world w_c, and a background of information A_c. In a context $<t_c, w_c, A_c>$, the world w_c represents the *circumstance of evaluation* of the context. The parameter A_c is assigned a set X of propositions, whereas t_c and w_c are assigned moments *m*, *n* (proxy for the instant i_m and the set of histories H_n, respectively).

Given an utterance *e* taking place at moment *m*, a context for *e* is a triple $<m, n, X>$ satisfying the condition $m \leq n$. This must be satisfied in order for the triple to count as a *proper* context for *e*. The motivation for this is straightforward: provided that *m* is the moment at which *e* takes place, it follows that for any $v < m$, *e* has not occurred at (the instant of) *v* yet, i.e. *e* is not yet actual at *v*, with the consequence that it would not be adequate to take *v* as representing a world of the utterance (given the contingency of any utterance event, *v* certainly has possible futures in which the utterance does not take place). We emphasize that the condition $m \leq n$ is not an arbitrary stipulation, but is rather a natural fall-out of the indeterministic view underlying BT semantics (as is clear from the Conservativity Principle).

We assume a referential treatment of tense: each tense is associated with a time variable (ranging over instants) which is presupposed to take its values from a particular temporal region, depending on which tense is considered.[30] With the past tense, the presupposition is that the temporal variable ranges over times that precede the utterance time, while with the present tense, the temporal variable is presupposed to range over times that coincide with the utterance time. Because of our referential approach to tense, we have no need to introduce temporal operators. This provides a motivation for the exclusion of the time parameter from circumstances of evaluation.

The adoption of a BT model, with the related distinction between moments (elements of the set U) and time instants (elements of the quotient structure I), raises some technical problems that we must address before specifying the details of our semantics. One problem has to do with the interpretation of verbs: what kind of temporal arguments do verbs take? Do they take moments or instants as their temporal arguments?

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[29] We will occasionally use the symbol '≤' without any subscript, letting the context specify what the intended relation is in each case.

[30] Referential/presuppositional treatments of tense have been proposed by Heim (1994) and von Stechow (1995), among others.

Another problem concerns the interpretation of tenses and time adverbs; both tenses and time adverbs are associated with time variables and other time-referring terms, so the question arises whether such terms denote moments or instants.
We will make the following assumptions:

(a1) Temporal arguments of verbs are instantiated by moments;

(a2) time-referring terms associated with tenses and time adverbs denote instants.

When the contextual assumptions play a role at all in the semantic evaluation, what they do is to narrow down the set of histories H_v corresponding to the world of the context.[31] A case in which the assumptions *do* play a role is that of (1a) (repeated below) in the context described in sect. 1.

(1) a. The Olympic Games will take place in China.

Suppose that X is the set of contextual assumptions (X includes the information available on January 24th, 2008, in the scenario described in sect. 1), and *m* is the moment at which the utterance takes place. We can specify the temporally most primitive context for the utterance as the triple <*m*, *m*, X>, and ask whether sentence (1a) is true or false in this context. In Kaplanian terms, this will be the same as asking whether (1a) is true relative to context <*m*, *m*, X> and to its circumstance of evaluation *m*. As we saw in sect. 1, the intuition is that (1a) is *true* in <*m*, *m*, X>. This result is achieved by letting the information in X interact with the cluster of histories H_m. The effect of this interaction is the elimination of those histories $h \in H_m$ on which the Olympic Games do not take place in China: taking X* as the set of histories compatible with the information in X, the interaction produces the restricted world $H_m \cap X^*$. It is the contextual restriction to the set $H_m \cap X^*$ that ensures the truth of (1a) in the context <*m*, *m*, X>, whereas if we had evaluated (1a) relative to the non-restricted set H_m, we would have faced histories on which the Olympic Games do not take place in China, and this would have prevented the sentence from coming out true. Notice, however, that the contextual assumptions do not always have a role to play in the semantic evaluation, as there are contexts in which the real facts come to override the assumptions. For instance, suppose to evaluate the same utterance of (1a) in a temporally more evolved context <*m*, *n*, X> in which the facts at *n* are such that it has become objectively settled that the Olympic Games do not take place in China. The scenario might be as follows. An unexpected event occurred at some moment between *m* and *n*, and forced the Olympic Committee to designate Japan as the new site for the event. In this case, the intuition is that the original utterance of (1a) becomes *false*. We guarantee this outcome by ignoring the assumptions in X and looking *only* at the state of the world at *n*, that is we evaluate (1a) relative to the non-restricted set H_n, in which we only face histories on which the Olympic Games do not take place in China.[32]
In what follows, we will need a way to specify what the relevant domain of histories is in each case. A general way to specify this is as follows: assume that there is a function *f* such that, for any context c = <*m*, *n*, X> and circumstance of evaluation *w*, *f*(*w*, c) specifies the semantically relevant domain of histories, where *f*(*w*, c) can be either $H_w \cap X^*$ or simply H_w. Intuitively, *f*(*w*, c) = $H_w \cap X^*$ when the evaluation takes place at the utterance time, i.e. *w* = *m* (then information in X plays a decisive role in guaranteeing that settledness obtains), whereas *f*(*w*, c) = H_w when the evaluation takes

[31] The world of the context v, taken on the background of the assumptions in X, can be seen as an *informationally restricted world*: the world which contains all those histories passing through v which are compatible with the background of information X.

[32] The semantic role played by contextual assumptions in our proposal can be assimilated to the one played by the ordering source in Kratzerian accounts of modals (see Kratzer 1981; see also Werner 2006 for a recent proposal in which ordering sources play a crucial role). We can make the similarity a little more explicit: what in Kratzerian accounts is referred to as *modal base* corresponds in our account to a whole branching structure H_m; furthermore, as the ordering source *g* of Kratzerian accounts interacts with the modal base M to select those worlds out of M that mostly conform to the norms contained in *g*, in a similar way the contextual assumptions of our account interact with the BT world H_m to filter out those histories $h \in H_m$ that do not conform to them.

place at a time at which the relevant issue has become objectively settled (then information in X is no longer a decisive factor in guaranteeing satisfaction of settledness).
Our main goal is to give a definition of truth of a sentence in a context.[33] We start from the definition of denotation of an expression relative to a context, an assignment, and a circumstance of evaluation or *index*.

6.2 Denotation relative to a context c, an assignment g, and an index *w*[34]

For singular terms (proper names), we have semantic clauses like the following:

$[\![[_{DP}\ \text{Leo}]]\!]^{c,g,w} = \text{Leo}$

This makes it clear that proper names like 'Leo' are treated as non-indexical rigid designators. This means that the denotation of such expressions is independent of both the context and the index.[35]
Turning now to the indexical temporal adverbs 'now', 'today', 'tomorrow', and 'yesterday', we assume the semantic clauses given below. The functor 'day' denotes a function which maps a moment *m* onto the set of instants in the day including *m*. The functor 'f' (respectively, 'p') denotes a function which maps the set of instants in some day *d* onto the set of instants in the day which immediately follows (respectively, precedes) *d*. The functor 'M' denotes a function which maps any set of histories *w* onto the set of moments lying within some history or other in the set *w*.

$[\![[_{AdvP}\ \text{now}]]\!]^{c,g,w} = \lambda P.\lambda v.[P(v) \wedge v \in i_{t_c} \cap M(w)]$
$[\![[_{AdvP}\ \text{today}]]\!]^{c,g,w} = \lambda P.\lambda v.[P(v) \wedge \exists i\ [i \in \text{day}(t_c) \wedge v \in i \cap M(w)]]$
$[\![[_{AdvP}\ \text{tomorrow}]]\!]^{c,g,w} = \lambda P.\lambda v.[P(v) \wedge \exists i\ [i \in f(\text{day}(t_c)) \wedge v \in i \cap M(w)]]$
$[\![[_{AdvP}\ \text{yesterday}]]\!]^{c,g,w} = \lambda P.\lambda v.[P(v) \wedge \exists i\ [i \in p(\text{day}(t_c)) \wedge v \in i \cap M(w)]]$

Let's use *temporal predicate* to refer to functions from moments to truth values. All these adverbs denote functions from temporal predicates to temporal predicates. In the case of 'now', this function takes a temporal predicate P as argument and yields the temporal predicate which holds of those moments which are P, are co-temporal to the utterance moment, and belong to the set of moments in the circumstance of evaluation. The other semantic clauses are similar, differing only with respect to which set of instants is relevant (this is the day of the context, $\text{day}(t_c)$, in the case of 'today', the day following $\text{day}(t_c)$ in the case of 'tomorrow', and the day preceding $\text{day}(t_c)$ in the case of 'yesterday'). Each one of these clauses makes clear that the corresponding temporal adverb is treated both as indexical (it is sensitive to the utterance time) and as local to the index (in the sense that the resulting temporal predicate holds only of moments in the set $M(w)$).
Locality to the index is a feature that the following semantic clauses also exhibits:

$[\![[_{AdvP}\ \text{at three p.m.}]]\!]^{c,g,w} = \lambda P.\lambda v.[P(v) \wedge \exists i\ [3\text{pm}(i) \wedge v \in i \cap M(w)]]$
$[\![[_{Tense}\ \text{past}_j]]\!]^{c,g,w} = \lambda P{:}\ g(j) < i_{t_c}.\ \exists v\ [P(v) \wedge v \in g(j) \cap M(w)]$

---

[33] Whenever we speak of context without further qualifications, we mean 'context of utterance'. No ambiguity should arise, as contexts of utterance are the only contexts we admit in our system.
[34] In the ensuing formalizations, we will have to deal with many different variables and parameters, even within a single lexical entry. In order to avoid confusion, we stick to the convention of using 'c' for the *context-of-utterance* parameter, 'g' for the *assignment* parameter, and '*w*' for the *index* (*circumstance-of-evaluation*) parameter. We remind the reader that a context of utterance is represented as a triple <m, n, X>, with m, n moments in U, and X a set of propositions. We recall that for any context c = <m, n, X>, the parameter n corresponds to the circumstance of evaluation of c. Our convention of using '*w*' for the *circumstance-of-evaluation* parameter should help the reader to keep in mind that this is what in our formalization corresponds to the evaluation world of classical intensional semantics.
[35] If we were interested in dealing with Kaplanian indexicals like first-person pronoun 'I', we might give semantic clauses like the following (the clause presupposes a suitable extension of our formal representation of contexts, so as to accommodate an extra coordinate s_c corresponding to the speaker of the context):

$[\![[_{DP}\ \text{I}]]\!]^{c,g,w} = s_c$

This would highlight the rigidity of Kaplanian indexicals, i.e. the independence of their denotation from the evaluation world.

$[\![[_{\text{Tense}} \text{pres}_j]]\!]^{c,g,w} = \lambda P: g(j) = i_{tc}. \exists v [P(v) \wedge v \in g(j) \cap M(w)]$
$[\![[_{V} \text{leave}]]\!]^{c,g,w} = \lambda v. \lambda x.$ x leaves at v $\wedge$ v $\in M(w)$

The locality feature is in order here, as each one of the above temporal elements (time adverbs, tenses, verbs) contributes to propositions whose truth values are to be determined relative to the index *w*, hence only what happens within *w* is relevant.
One comment is in order concerning the lexical entries for the two tenses. Here we use a version of the lambda notation which enables us to express partial functions. For example, the lambda term '$\lambda P: g(j) < i_{tc}. \exists v [P(v) \wedge v \in g(j) \cap M(w)]$' in the lexical entry for the past denotes a function which is defined only for temporal predicates which satisfy the condition '$g(j) < i_{tc}$'. The condition '$g(j) < i_{tc}$' expresses a presupposition associated with the tense '$past_j$', according to which the value assigned to variable 'j' has to precede the utterance time. By specifying the presupposition '$g(j) < i_{tc}$' in the lexical entry for '$past_j$', we integrate it in the semantic value of '$past_j$'. Indeed, if the condition '$g(j) < i_{tc}$' is not true, whatever predicate P we select to feed the function $[\![past_j]\!]^{c,g,u}$ will be outside of its domain (since the variable 'P' does not occur free in the condition '$g(j) < i_{tc}$', either *every* value of 'P' will satisfy it, or *no* value will, depending on whether the condition itself is *true* or *false*; if the condition is false, no temporal predicate will fall in the domain of the function), therefore we will never be able to apply the function to get a semantic value for the node immediately dominating Tense, with the consequence that any higher node in the LF structure will wind up without a semantic value.[36]

The interpretation of 'will'

We propose a modal analysis of 'will' on which its denotation is a partial function, which applies only to intensional properties satisfying a condition of settledness. The idea is twofold:

(a) 'will'-sentences are modal sentences involving universal quantification over a contextually specified domain of histories; relative to context c = <*m*, *n*, X> and index *w*, the quantificational domain *f*(*w*, c) can be either the restricted set $H_w \cap X^*$ or the unrestricted H_w, depending on which one among the set of assumptions X and the state of the world at *w* is prevailing over the other

(b) 'will'-sentences get a truth value only if the occurrence of the event they report does not make a difference between the historical alternatives contained in the quantificational domain of 'will' (either the event occurs in every one of these alternatives, or in none).

In the lexical entry for 'will', Π is a variable over *temporal properties*, i.e. functions which take a world as their argument and yield a temporal predicate as their value. For instance, the temporal property corresponding to the clause 'Leo leaves' is the function which applies to any world u and yields the following temporal predicate as value for u: that function *f* such that for any moment v, *f*(v) = 1 if Leo leaves at v and v belongs to M(u), and *f*(v) = 0 otherwise.[37]
The complete lexical entry for 'will' is given below. Preliminarily, we have to define the settledness condition. We introduce a three-place predicate '*Settled*', which takes a temporal property Π, an instant *i*, and a world *w* as arguments, and intuitively expresses the information that Π is instantiated in the future of *i* on every history belonging to world *w* or on no such history. Settledness is defined as follows:

Settled(Π, *i*, *w*) $=_{Def} \forall h \in H_w \exists z \in h [i < z \wedge \Pi(w)(z)] \vee \forall h \in H_w \neg \exists z \in h [i < z \wedge \Pi(w)(z)]$

[36] This is the way Heim and Kratzer (1998) adopt to represent the presupposition of a lexical item x into the lexical entry for x.
[37] The fact that 'will' denotes a function from intensions is what one expects, given the assumption that 'will' is a modal, and the standard treatment of modals as intensional expressions.

Settledness enters in the expression of the semantic value of 'will',[38] as shown by the following clause:

$[\![\ [_{\text{ModalAux}}\ \text{will}]\ ]\!]^{c,g,w} = \lambda\Pi.\ \lambda v\text{: } \textit{Settled}(\Pi, i_v, f(w, c)).\ \forall h \in f(w, c)\ \exists z \in h\ [i_v < z \wedge \Pi(f(w, c))(z)]$

Because of this condition, the semantic value of 'will' turns out to be a partial function which is defined for a temporal property Π and a moment v only if Π is instantiated after i_v either on every history in the domain, or on no such history.

6.3 Truth in context

We give a definition of truth in context which conforms to the usual one from Kaplan (1989).

Definition (truth in context)

A sentence S is true in a context c if and only if S is true relative to c and the circumstance of evaluation of c.

Taking c = <u,v,X>, the definition is formally the following (recall that the circumstance of evaluation of c is the moment v; to avoid unnecessary complications, we avoid reference to the assignment parameter in what follows):

$[\![\varphi]\!]^{<u,v,X>} = 1$ *iff* $[\![\varphi]\!]^{<u,v,X>,\,v} = 1$

$[\![\varphi]\!]^{<u,v,X>} = 0$ *iff* $[\![\varphi]\!]^{<u,v,X>,\,v} = 0$

$[\![\varphi]\!]^{<u,v,X>}$ is undefined otherwise.

To illustrate this notion, we analyse two paradigmatic cases.

Example 1. The Sea Battle

Consider the following sentence:

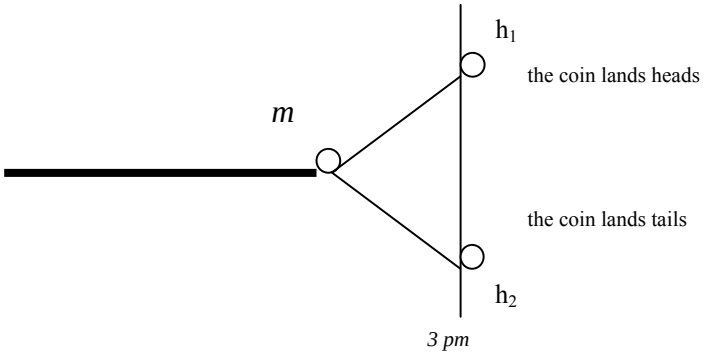
(15) The coin will land heads.

This is an example of the classical Sea Battle predicament. We will deal with it to show what predictions our analysis make about this venerable issue. We consider two cases in turn.

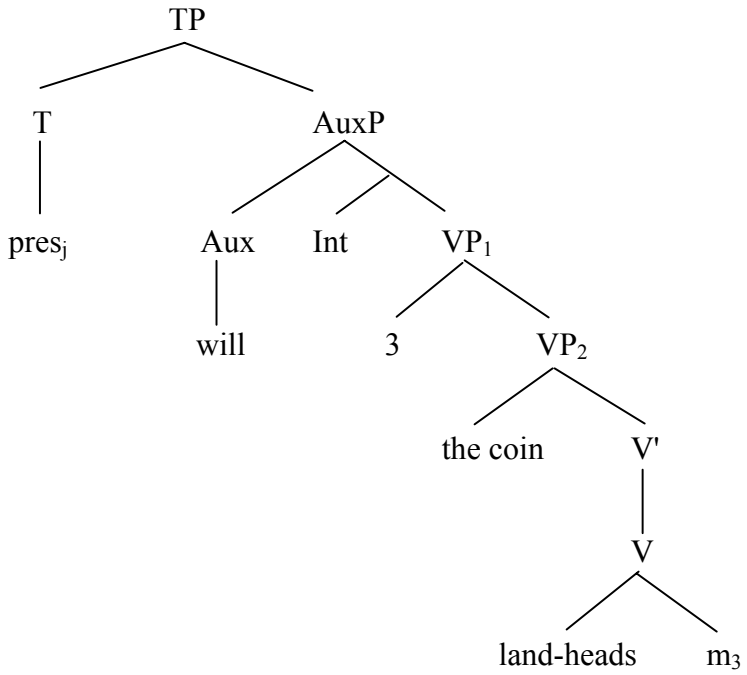
Case 1. Suppose that sentence (15) is uttered at the same time as you flip a coin which is known to be physically symmetrical. Therefore, relative to the assumptions that are in place at the time of the utterance, it is not settled whether the coin will land heads up. Assume that the moment at which the utterance takes place is *m*, and the set of assumptions at *m* is X. Assume further that only two future courses of events, corresponding to histories h_1 and h_2, are open possibilities at *m* given the assumptions in X. Because of the relevant issue being unsettled at *m*, there must be a difference between h_1 and h_2 with respect to the outcome. Suppose that the coin lands heads on h_1, but tails on h_2. We can picture this situation by drawing the diagram below.

[38] Our proposal does not hinge on the assumption of an existential quantification over moments in the scope of a universal quantification over histories. What is essential to it is instead the idea that 'will' is a modal of "settledness", hence a universal quantifier over histories. Here, we confine ourselves to noting that existential quantification over moments could be dispensed with by means of a formal analysis of the semantic contribution of actionality to temporal interpretation (e.g. along the lines of Condoravdi 2001, 2003).

Fig. 6



The intuition is that (15), if evaluated relative to *m*, given the assumptions in X, is neither true nor false. Thus, if our analysis is to be considered empirically adequate, it must predict that the denotation of (15) in the context c = <*m*, *m*, X> (the original utterance context) is not defined. This is the way the analysis captures the intuition that (15) is neither true nor false in the envisaged situation. In this case, the quantificational domain is $f(m,c) = H_m \cap X^* = \{h_1, h_2\}$. We will try to derive (15)'s denotation in a step-wise fashion, working bottom-up on the following tree:



What we obtain is the following derivation:

$[\![V']\!]^{c,g,m} = [\![V]\!]^{c,g,m} = [\![\text{land-heads}]\!]^{c,g,m}([\![m_3]\!]^{c,g,m})$

$= (\lambda v.\ \lambda x.\ x \text{ lands heads at } v \wedge v \in M(m))(g(m_3)) = \lambda x.\ x \text{ lands heads at } g(m_3) \wedge g(m_3) \in M(m)$

$[\![VP_2]\!]^{c,g,m} = [\![V']\!]^{c,g,m}([\![\text{the coin}]\!]^{c,g,m})$

$= (\lambda x.\ x \text{ lands heads at } g(m_3) \wedge g(m_3) \in M(m))(\text{Leo}) = \text{the coin lands heads at } g(m_3) \wedge g(m_3) \in M(m)$

$[\![VP_1]\!]^{c,g,m} = [\![3\ VP_2]\!]^{c,g,m} = \lambda k.\ [\![VP_2]\!]^{c,g[m3/k],m} = \lambda k.\ \text{the coin lands heads at } k \wedge k \in M(m)$ [39]

$[\![\text{Int } VP_1]\!]^{c,g,m} = \lambda w.\ [\![VP_1]\!]^{c,g,w}$

[39] $g[m_1/k]$ is the assignment function which is like g except that it assigns moment *k* to variable m_1 as value.

= λw. λv.[the coin lands heads at v ∧ v ∈ M(w)]

$[\![\text{AuxP}]\!]^{c,g,m} = [\![\text{will}]\!]^{c,g,m}([\![\text{Int VP}_1]\!]^{c,g,m})$

= (λΠ. λv: Settled(Π, i_v, $f(m,c)$). ∀h∈$f(m,c)$ ∃z∈h [i_v < z ∧ Π($f(m,c)$)(z)])(λw. λv.[the coin lands heads at v ∧ v ∈ M(w)])

= λv: Settled(λw. λv.[the coin lands heads at v ∧ v ∈ M(w) ∧ ∃i [3pm(i) ∧ v ∈ i ∩ M(w)]], i_v, $f(m,c)$). ∀h∈$f(m,c)$ ∃z∈h [i_v < z ∧ the coin lands heads at z ∧ z ∈ M($f(m,c)$)]

$[\![\text{TP}]\!]^{c,g,m} = [\![\text{pres}_k]\!]^{c,g,m}([\![\text{AuxP}]\!]^{c,g,m})$

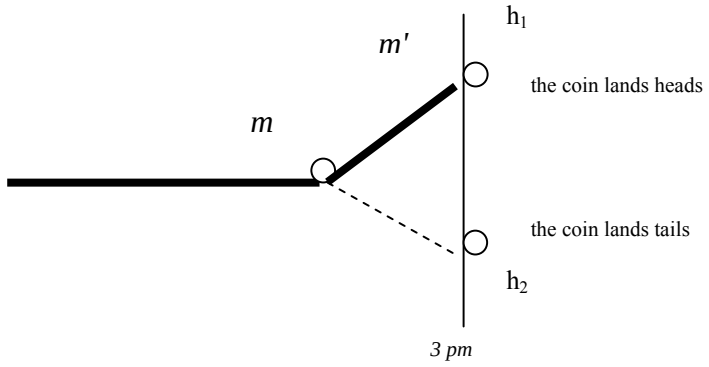
= (λP: g(k) = i_{tc}. ∃v [P(v) ∧ v ∈ g(k) ∩ M(m)])(λv: Settled(λw. λv.[the coin lands heads at v ∧ v ∈ M(w)], i_v, $f(m,c)$). ∀h∈$f(m,c)$ ∃z∈h [i_v < z ∧ the coin lands heads at z ∧ z ∈ M($f(m,c)$)])

= ∃v [(λv: Settled(λw. λv.[the coin lands heads at v ∧ v ∈ M(w)], i_v, $f(m,c)$). ∀h∈$f(m,c)$ ∃z∈h [i_v < z ∧ the coin lands heads at z ∧ z ∈ M($f(m,c)$)])(v) ∧ v ∈ g(k) ∩ M(m)]
[*definedness condition*: g(k) = i_{tc}]

At the last step, the semantic composition comes to a halt: in order to apply the temporal predicate $[\![\text{AuxP}]\!]^{c,g,m}$ to the moment v quantified over by the present tense, the condition '*Settled*(λ*w*. λv.[the coin lands heads at v ∧ v ∈ M(*w*)], i_v, $f(m,c)$)' must be satisfied, i.e. the temporal property λ*w*. λv.[the coin lands heads at v ∧ v ∈ M(*w*)] must be instantiated in the future of i_v either on every history belonging to the restricted world $f(m,c)$ or on no such history. But as we can see in Fig. 6 above, there is a history in $f(m,c)$ in which the coin does not land heads, namely h_2. As a consequence, the temporal predicate $[\![\text{AuxP}]\!]^{c,g,m}$ is not defined for the argument v, and the denotation function $[\![\ ]\!]^{c,g,m}$ does not yield any value for TP.

Case 2. Suppose now that the same utterance of (15) is evaluated at a subsequent moment $m' > m$. Suppose further that m' is the moment at which the coin lands heads up (see Fig. 7 below). The utterance time remains the same as before, as it is univocally determined by m. Our current supposition is that (15) is evaluated in a new context, whose world is temporally more evolved than the world of the original context.

Fig. 7



The intuition is that (15), if evaluated relative to m', is true. Therefore, the analysis has to predict that the denotation of (15) in the context c' = <m, m', X> is the True. It is easy to verify that this is the prediction made by the analysis. We leave the derivation to the reader. We just observe that the temporal property λ*w*. λv.[the coin lands heads at v ∧ v ∈ M(*w*)] is settled in world m': in every possible future with respect to m' there is a moment m'' such that $m < m''$ and the coin lands heads at m'' (this moment is m' itself). We further observe that it is metaphysical settledness that is obtained in this case, as we no longer need to take into account the contextual assumptions in order to have

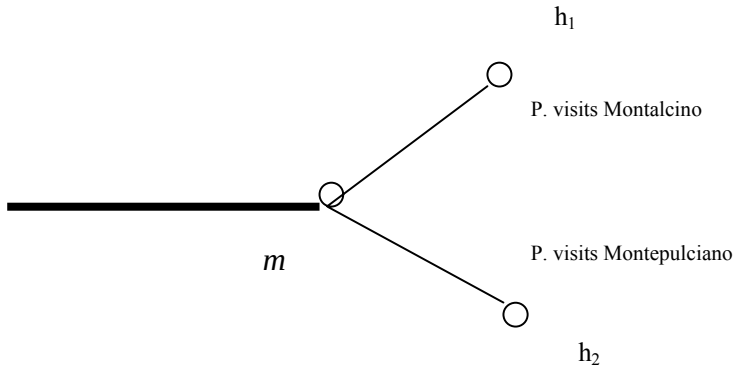
the settledness condition satisfied. The quantificational domain $f(m',c')$ in this case is the unrestricted $H_{m'}$, the reason being that at m' the real facts become prevailing over the assumptions.
We have shown that our analysis correctly predicts intuitive judgments about the transition of the truth-status of (15) from *neither true nor false* to *true* in the envisaged situations. We stress that both in Case 1 and in Case 2 we dealt with the notion of *truth in context.*

Example 2. The Multiple Choice Paradox

(11) a. Prodi will visit Montepulciano or Montalcino.
b. Prodi will visit Montepulciano.
c. Prodi will visit Montalcino.

As we saw in section 3 above, sentence (11a) might be accepted as true in a context c, without either one of (11b), (11c) being so accepted in c. This would happen in the following scenario: the Cabinet Council has decided that Prodi will visit one of the two towns, but which one of them he will visit is still undecided; on this background, (11a) is uttered at moment *m*. For simplicity, let's assume that only two future courses of events are open possibilities at *m*, given the assumptions in X (these will include the information that the relevant decision has been taken by the Cabinet Council). In one of them Prodi visits Montalcino at some moment in the future of *m*, in the other he visits Montepulciano at some such moment. The situation can be depicted as in figure 8.

Fig. 8



We can thus state the following facts:

Fact 1: the utterance of (11a) in the context c = <*m*, *m*, X> expresses a proposition that is true if evaluated at the index *m* of the context.

Fact 2: the utterance of either one of (11b,c) in the context c = <*m*, *m*, X> expresses a proposition that is truth-valueless at the index *m* of the context.

An empirically adequate semantic theory must be able to account for both these facts. Let's start from fact 1, and check whether our theory makes the correct prediction.
Concerning the LF syntax of (11a), we assume that 'or' coordinates the DPs 'Montepulciano' and 'Montalcino', and that the coordinated structure 'Montepulciano or Montalcino' is a DP too. We follow Partee & Rooth (1983) in assuming that a "generalized disjunction" interpretation for 'or' is available, in which 'or' denotes a function taking two objects of any conjoinable type τ as arguments and yielding an object of the same type τ as value.[40] As shown in Partee & Rooth, the "generalized disjunction" interpretation of 'or' can be defined from its basic interpretation as the sentential operator $\vee$ (defined by the familiar truth-table). For our purposes, we confine ourselves to the

[40] Partee & Rooth give the following recursive definition of 'conjoinable type' (p. 363):
(i) t is a conjoinable type
(ii) if b is a conjoinable type, then for all a, <a, b> is a conjoinable type.

case of 'or' coordinating two DPs. In this case, 'or' will denote a function in the domain of generalized quantifiers. This function can be defined in the following way ('Σ', 'T' are variables of type <<e,t>,t> - generalized quantifier variables; 'P' is a type-<e,t> variable):

$[\![\text{or}]\!] = \lambda\Sigma.\ \lambda T.\ \lambda P.\ [\Sigma(P) \vee T(P)]$[41]

An obvious consequence of this analysis is that DPs coordinated by 'or' will have denotations of type <<e,t>,t>, even if they are proper nouns. Thus far, we have assumed that proper nouns like 'Leo' or 'Prodi' have denotations of the lowest type possible for a DP, namely type-e denotations. In order to cope with (11a), we will assume that the proper nouns 'Montepulciano' and 'Montalcino' are raised to the higher type of generalized quantifiers, in accordance with Partee & Rooth's hypothesis about type-raising. Their derived interpretations are given in (a)ii and (b)ii (we omit relativization to parameters as not relevant here):

(a) i. $[\![[_{DP}\ \text{Montepulciano}]]\!] = \text{Montepulciano}$
ii. $[\![[_{DP}\ \text{Montepulciano}]]\!] = \lambda P.\ P(\text{Montepulciano})$

(b) i. $[\![[_{DP}\ \text{Montalcino}]]\!] = \text{Montalcino}$
ii. $[\![[_{DP}\ \text{Montalcino}]]\!] = \lambda P.\ P(\text{Montalcino})$

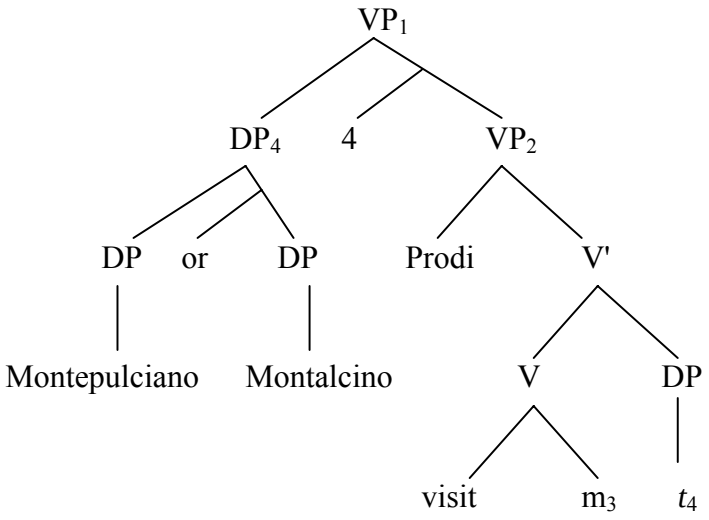
On the basis of (a)ii and (b)ii, and assuming the interpretation of 'or' given above, it is possible to determine the generalized quantifier interpretation of 'Montepulciano or Montalcino':

$[\![[_{DP}\ \text{Montepulciano or Montalcino}]]\!] = (\lambda\Sigma.\ \lambda T.\ \lambda P.\ [\Sigma(P) \vee T(P)])(\lambda P.\ P(\text{Montepulciano}))(\lambda P.\ P(\text{Montalcino}))$

$= \lambda P.\ [(\lambda P.\ P(\text{Montepulciano}))(P) \vee (\lambda P.\ P(\text{Montalcino}))(P)]$

$= \lambda P.\ [P(\text{Montepulciano}) \vee P(\text{Montalcino})]$

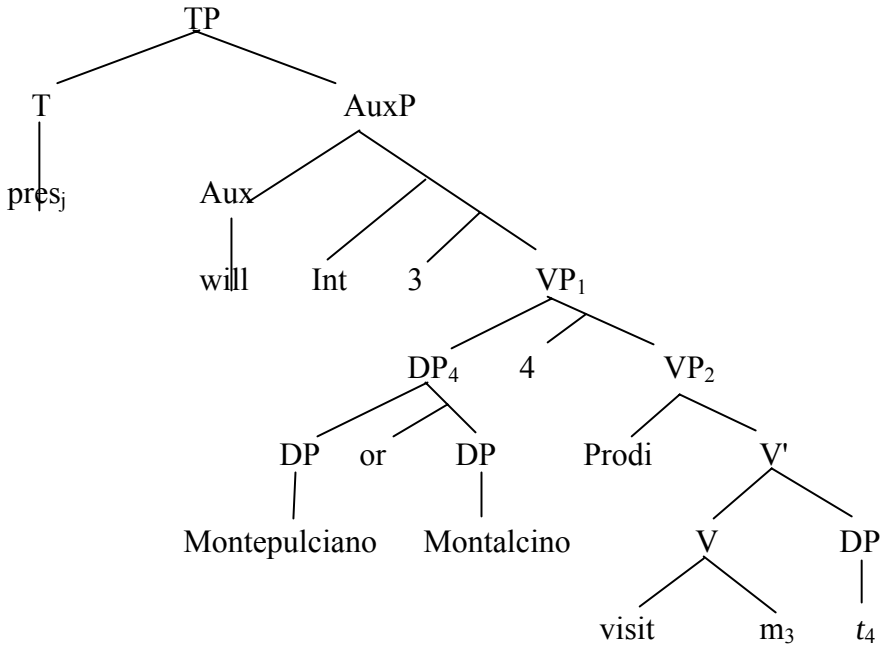
The coordinated DP 'Montepulciano or Montalcino' will thus denote the set of properties P such that either Montepulciano has P or Montalcino has P. Being of the semantic type of generalized quantifiers, this DP undergoes Quantifier Raising (QR) at LF. We assume that QR adjoins it to the VP headed by 'visit', giving rise to the following structure:



The full LF of (11a) is represented by tree (11aLF):

[41] We omit to relativize the denotation function to any parameters, as 'or', being a logical constant, has a denotation which is independent of context, assignment, and index.

(11aLF)



Here, the future auxiliary 'will' takes scope over the disjunction 'or'. As will become clear in a while, this feature of our analysis, paired with our modal treatment of 'will', is at the heart of the solution to the MCP that we propose.

We have now to compute the truth-value of (11a) in the context c = <*m*, *m*, X>. Recall that the quantificational domain $f(m,c)$ is now the informationally restricted set $H_m \cap X^*$ (intuitively, the contextual assumptions, including the assumption that the Cabinet Council has taken the deliberation, restrict the domain of 'will' to histories on which Prodi visits one of the two towns). As before, we proceed bottom-up on the tree (11aLF). We obtain the following derivation:

$[\![V]\!]^{c,g,m} = [\![\text{visit}]\!]^{c,g,m}([\![m_3]\!]^{c,g,m})$
$= (\lambda v.\ \lambda y.\ \lambda x.\ x \text{ visits } y \text{ at } v \wedge v \in M(m))(g(m_3))$
$= \lambda y.\ \lambda x.\ x \text{ visits } y \text{ at } g(m_3) \wedge g(m_3) \in M(m)$

$[\![V']\!]^{c,g,m} = [\![V]\!]^{c,g,m}([\![t_4]\!]^{c,g,m})$
$= (\lambda y.\ \lambda x.\ x \text{ visits } y \text{ at } g(m_3) \wedge g(m_3) \in M(m))(g(t_4))$
$= \lambda x.\ x \text{ visits } g(t_4) \text{ at } g(m_3) \wedge g(m_3) \in M(m)$

$[\![VP_2]\!]^{c,g,m} = [\![V']\!]^{c,g,m}([\![\text{Prodi}]\!]^{c,g,m}) = (\lambda x.\ x \text{ visits } g(t_4) \text{ at } g(m_3) \wedge g(m_3) \in M(m))(\text{Prodi})$
$= \text{Prodi visits } g(t_4) \text{ at } g(m_3) \wedge g(m_3) \in M(m)$

$[\![4\ VP_2]\!]^{c,g,m} = \lambda x.\ [\![VP_2]\!]^{c,g[t4/x],m} = \lambda x.\ \text{Prodi visits } x \text{ at } g(m_3) \wedge g(m_3) \in M(m)$

$[\![VP_1]\!]^{c,g,m} = [\![DP_4]\!]^{c,g,m}([\![4\ VP_2]\!]^{c,g,m})$
$= (\lambda P.[P(\text{Montepulciano}) \vee P(\text{Montalcino})])(\lambda x.\ \text{Prodi visits } x \text{ at } g(m_3) \wedge g(m_3) \in M(m)) =$
$= [\text{Prodi visits Montepulciano at } g(m_3) \wedge g(m_3) \in M(m)] \vee [\text{Prodi visits Montalcino at } g(m_3) \wedge g(m_3) \in M(m)]$

$[\![3\ VP_1]\!]^{c,g,m} = \lambda k.\ [\![VP_1]\!]^{c,g[m3/k],m}$
$= \lambda k.\ [\text{Prodi visits Montepulciano at } k \wedge k \in M(m)] \vee [\text{Prodi visits Montalcino at } k \wedge k \in M(m)]$

$[\![\text{Int } 3\ VP_1]\!]^{c,g,m} = \lambda w.\ [\![3\ VP_1]\!]^{c,g,w}$
$= \lambda w.\ \lambda k.\ [\text{Prodi visits Montepulciano at } k \wedge k \in M(w)] \vee [\text{Prodi visits Montalcino at } k \wedge k \in M(w)]$

$[\![\text{AuxP}]\!]^{c,g,m} = [\![\text{will}]\!]^{c,g,m}([\![\text{Int } 3\ VP_1]\!]^{c,g,m})$

= (λΠ. λv: *Settled*(Π, i_v, *f*(*m*,c)). ∀h∈*f*(*m*,c) ∃z∈h [i_v < z ∧ Π(*f*(*m*,c))(z)])(λ*w*. λ*k*. [Prodi visits Montepulciano at *k* ∧ *k* ∈ M(*w*)] ∨ [Prodi visits Montalcino at *k* ∧ *k* ∈ M(*w*)])

= λv: *Settled*(λ*w*. λ*k*. [Prodi visits Montepulciano at *k* ∧ *k* ∈ M(*w*)] ∨ [Prodi visits Montalcino at *k* ∧ *k* ∈ M(*w*)], i_v, *f*(*m*,c)). ∀h∈*f*(*m*,c) ∃z∈h [i_v < z ∧ [Prodi visits Montepulciano at *z* ∧ *z* ∈ M(*f*(*m*,c))] ∨ [Prodi visits Montalcino at *z* ∧ *z* ∈ M(*f*(*m*,c))]]

$[\![TP]\!]^{c,g,m}$ = $[\![pres_j]\!]^{c,g,m}([\![AuxP]\!]^{c,g,m})$

= (λP: g(j) = i_{tc}. ∃v [P(v) ∧ v ∈ g(j) ∩ M(*m*)])(λv: *Settled*(λ*w*. λ*k*. [Prodi visits Montepulciano at *k* ∧ *k* ∈ M(*w*)] ∨ [Prodi visits Montalcino at *k* ∧ *k* ∈ M(*w*)], i_v, *f*(*m*,c)). ∀h∈*f*(*m*,c) ∃z∈h [i_v < z ∧ [Prodi visits Montepulciano at *z* ∧ *z* ∈ M(*f*(*m*,c))] ∨ [Prodi visits Montalcino at *z* ∧ *z* ∈ M(*f*(*m*,c))]])

= ∃v [(λv: *Settled*(λ*w*. λ*k*. [Prodi visits Montepulciano at *k* ∧ *k* ∈ M(*w*)] ∨ [Prodi visits Montalcino at *k* ∧ *k* ∈ M(*w*)], i_v, *f*(*m*,c)). ∀h∈*f*(*m*,c) ∃z∈h [i_v < z ∧ [Prodi visits Montepulciano at *z* ∧ *z* ∈ M(*f*(*m*,c))] ∨ [Prodi visits Montalcino at *z* ∧ *z* ∈ M(*f*(*m*,c))]])(v) ∧ v ∈ g(j) ∩ M(*m*)]

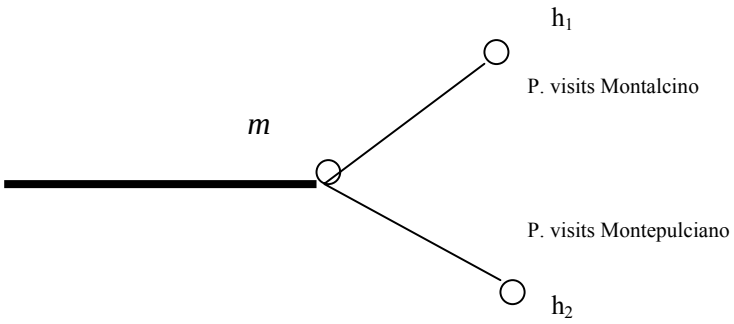
[*definedness condition*: g(j) = i_{tc}]

= ∃v [∀h∈*f*(*m*,c) ∃z∈h [i_v < z ∧ [Prodi visits Montepulciano at *z* ∧ *z* ∈ M(*f*(*m*,c))] ∨ [Prodi visits Montalcino at *z* ∧ *z* ∈ M(*f*(*m*,c))]] ∧ v ∈ g(j) ∩ M(*m*)]

[*definedness conditions*: g(j) = i_{tc}; *Settled*(λ*w*. λ*k*. [Prodi visits Montepulciano at *k* ∧ *k* ∈ M(*w*)] ∨ [Prodi visits Montalcino at *k* ∧ *k* ∈ M(*w*)], i_{tc}, *f*(*m*,c))]

This time, we *can* apply the partial function $[\![AuxP]\!]^{c,g,m}$ to the utterance moment *m*, as this moment *does* satisfy the definedness condition *Settled*(λ*w*. λ*k*. [Prodi visits Montepulciano at *k* ∧ *k* ∈ M(*w*)] ∨ [Prodi visits Montalcino at *k* ∧ *k* ∈ M(*w*)], i_v, *f*(*m*,c)). Indeed, at *m* it is definitely settled, relative to the contextual assumptions (i.e., in the restricted world *f*(*m*,c)), that Prodi visits Montepulciano or Montalcino at some moment in the future of *m* (see Fig. 8, repeated below).

Fig. 8



However, we can easily verify that neither one of the disjuncts (11b,c) would be true in the original context c = <*m*, *m*, X>. We leave the proof to the reader, and confine ourselves to observing that neither one of the corresponding definedness conditions (reported in (i) and (ii) below) is satisfied at *m*.

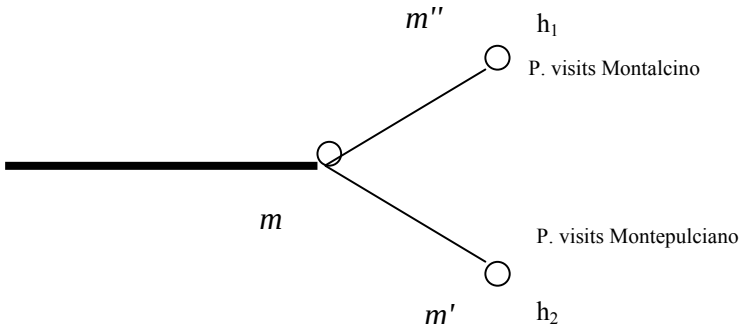
(i) *Settled*(λ*w*. λ*k*. [Prodi visits Montepulciano at *k* ∧ *k* ∈ M(*w*)], i_v, *f*(*m*,c))
[definedness condition for (11b)]

(ii) *Settled*(λ*w*. λ*k*. [Prodi visits Montalcino at *k* ∧ *k* ∈ M(*w*)], i_v, *f*(*m*,c))
[definedness condition for (11c)]

Before concluding this section, we observe that if (11b) or (11c) were evaluated relative to the index of a temporally more evolved context of utterance (for example, if they were evaluated in context <*m*, *m′*, X> or in context <*m*, *m″*, X>, where, for simplicity, *m′* is assumed to be the moment at which Prodi visits Montepulciano, and *m″* to be the moment at which he visits Montalcino, as represented in Fig. 9 below), they could obtain a definite truth-value then.

(11) b. Prodi will visit Montepulciano.
c. Prodi will visit Montalcino.

Fig. 9



In particular, (11b) would be definitely true in <*m*, *m'*, X> and false in <*m*, *m''*, X>, while (11c) the other way round, as desired

7. The epistemic reading of future sentences

In this section, we consider an intriguing reading of future sentences, in which no shift to a future time is present. Given the lack of temporal shift, this reading is a particularly interesting case of a purely modal interpretation of 'will', and provides particularly convincing evidence for the modal nature of this auxiliary. The non-temporal interpretation that we have in mind is referred to as "epistemic reading" in the recent literature (Condoravdi 2003, Werner 2006), and Jespersen (1924) had already described it under the heading 'Non-temporal use of tenses' in a passage that we report here:

> Thus a future tense is often used to express a mere supposition or surmise with regard to the present time: *il dormira déjà = he will already be asleep = er wird shon schlafen* (I suppose that he is asleep) and in the same way *il l'aura vu = he will have seen it = er wird es gesehen haben* (he has probably seen it). It is true that we can assert nothing with regard to a future time but mere suppositions and surmises, and this truth is here linguistically reversed as if futurity and supposition were identical. [Jespersen 1924, p. 265]

We will call the relevant use/reading 'epistemic future'. Our aim in this section is to show how the unified semantic analysis presented above can be made to deal with it.
Some examples of epistemic future are reported in (16) below (all the examples are taken from Condoravdi 2003):

(16) a. He will be in his room right now.
b. That will be the postman at the door.
c. She will have left the island yesterday.

Each of (16a, b, c) can be used to express a supposition relative to the present time, as Jespersen would have said (actually, (16c) can be seen as expressing a supposition relative to a time in the past, too). In the case of (16a, c), that no reference to a future time is made appears from the fact that in the first sentence the time of the eventuality[42] is specified by the adverb 'now', and in the second it is specified by the adverb 'yesterday'. The particular modal interpretations of (16a, b, c) make it most clear that the condition we called 'forward factivity' is not to be taken as constitutive of the truth-conditions of future sentences, if one is to provide a uniform semantic analysis for these sentences.

[42] We follow Bach (1986) in using the word 'eventuality' as a cover term which stands for states, activities, and events proper. Thus, the eventuality in (16a) is the *state* of the relevant person's being in his room, while in (16c) it is the *event* of the relevant person's leaving the island. Moreover, we use the expression 'time of the eventuality' informally, intending to refer to the time at which a certain eventuality takes place.

An important observation is that not all future sentences can be epistemic futures. In this connection, consider the semantic contrast between (17a) and (17b):

(17) a. John will be at home (now).
b. John will prove the theorem.

Clearly, only (17a) is an epistemic future, whereas (17b) cannot be used to express a supposition about the present time, but can only be interpreted as saying that an event of John's proving the theorem will occur at some time in the future. In order to obtain an epistemic future from (17b), one should introduce some "stativizing" device in the sentence, as shown by (18a,b):

(18) a. John will have proved the theorem.
b. John will be proving the theorem.

Both (18a) and (18b) have a reading in which they say something about the present time: (18a) says that John has probably proved the theorem by now, (18b) says that John is probably proving the theorem now. Both (18a) and (18b) differ from (17b) in that they have stative complements for 'will' instead of the bare eventive complement 'prove the theorem'. The way they get such stative complements from the underlying eventive predicate 'prove the theorem' is by means of the perfect and the progressive, respectively.
A generalization one might want to propose is that epistemic futures are possible only with stative complements for 'will'. From this point of view, there is an important difference between the type of modality of (17a) and that of (17b): the former is an epistemic future whereas the latter is not. The fact that (17a) is an epistemic future, i.e. the fact that it expresses a supposition about the present time, gives it a particular flavour which is missing from (17b).
The explanation we suggest for this is as follows: only suppositions about the present/past have the property of coming *à jeux faits*, thus the property of having a truth-status that is already decided by the court of actual facts, with the consequence that they are expressed as a modality that allows for non-actual worlds (i.e. worlds distinct from the actual world even on the present or the past: worlds that, for all the speaker knows, might well be the actual one). On the other hand, suppositions about the future, be the relevant issue as settled as it may, never come *à jeux faits* (how could that ever be?), with the consequence that they are expressed as a modality that only allows for different possible futures, but since different futures are also objectively possible, in this case we do not have any court of actual facts that may already decide the truth-status of the supposition. This is why suppositions about the future can never instantiate the same type of epistemic modality that suppositions about the present/past do instantiate.

In order to deal with epistemic futures, we fine-tune the semantic analysis by making it *interval-based*. First, we introduce intervals of moments into the ontology of our semantics, and take all the variables previously used as variables over moments to range over such intervals instead (correlatively, we introduce intervals of instants, and let our old instant variables range over such other intervals). In BT we can define intervals in exactly the same way as they are defined in linear time semantics: intervals of moments will be *linear convex sets* in the relational structure of moments (*mutatis mutandis*, the same holds for intervals of instants).[43] This allows for intervals containing only one moment (*zero measure intervals*). In the previously developed analysis, when 'v' referred to a moment $m \in U$, 'i_v' always referred to the instant to which *m* belongs. In the interval-based analysis, the same term 'v' no longer refers to a moment, but to an interval of moments *k*, and the complex term 'i_v' will refer to a corresponding interval of instants, that one whose members are the

[43] See Landman (1991: 110). Following Landman, we define a linear convex set (an interval) in the tree-like structure $\langle U, \leq \rangle$ as an $X \subseteq U$ satisfying the following conditions:

(i) $\forall m_0,m_1 \in X\ \forall m_2 \in U\ [m_0 \leq_U m_2 \leq_U m_1 \rightarrow m_2 \in X]$ (convexity in $\langle U, \leq \rangle$)

(ii) $\forall m_0,m_1 \in X\ [m_0 \leq_U m_1 \vee m_1 \leq_U m_0]$ (linearity)

instants of the moments belonging to *k*. More precisely, taking 'ι' and 'μ' as variables ranging over instants and moments, respectively, we can give the following definition:

$i_v =_{def} \{\iota: \exists\mu\ [\mu \in v \wedge \mu \in \iota]\}$

A relation of temporal precedence $<_I$ over intervals of moments is defined as follows:

$v <_I z =_{def} \forall\mu \in v\ \forall\mu' \in z\ \mu <_U \mu'$

The relation $<_I$ can be extended so as to order intervals of moments and intervals of instants, in an analogous way as the relation $\leq_U$ was extended so as to order moments and instants. For example: condition '$i_v <_I z$' means the same as 'the interval of moments z completely follows that interval of moments which contains those moments *m* belonging to instants in the interval of instants i_v such that *m* lies on the same history as z'.
Throughout our old lexical entries for the temporal elements of the language (verbs, time adverbs, tenses), we will substitute the symbol of set-theoretical inclusion $\subseteq$ for the symbol of membership $\in$. For example, the old lexical entry for the verb 'leave', given in sect. 6.2 above, will be restated as specified below, the reason for this change being that variable 'v' no longer ranges over moments, but over intervals of moments (hence, *sets* of moments).

$[\![\ [_V \text{leave}]\ ]\!]^{c,g,w} = \lambda v.\ \lambda x.\ x \text{ leaves at } v \wedge v \subseteq M(w)$

The lexical entry for the future auxiliary will be almost the same as before:

$[\![\ [_{\text{ModalAux}} \text{will}]\ ]\!]^{c,g,w} = \lambda\Pi.\ \lambda v\text{: } \textit{Settled}(\Pi, i_v, f(w, c)).\ \forall h \in f(w, c)\ \exists z \subseteq h\ [i_v <_I z \wedge \Pi(f(w, c))(z)]$

Of course, 'v' and 'z' are now variables ranging over intervals of moments, and condition '$i_v <_I z$' is to be understood as specified above.
Furthermore, we make a distinction between *eventive* (like 'to prove the theorem') and *non-eventive* (or *stative*, like 'to be at home') temporal predicates, in the following way:

(i) if P is an *eventive* temporal predicate and v an interval of moments, then the following conditional holds:
$P(v) \rightarrow \neg\exists z[\text{Init}(z, v) \wedge z \neq v \wedge P(z)]$[44]

(ii) if P is a *non-eventive* temporal predicate and v an interval of moments, then the following conditional holds:
$P(v) \rightarrow \forall z[z \subseteq v \rightarrow P(z)]$

Condition (i) is intended to apply to both accomplishments and achievements. Accomplishments typically are true of extended intervals, and condition (i) says that they are never true of their proper initial subintervals. This corresponds to the widely held view according to which accomplishments have culminations, and such culminations happen at the endpoints of the extended intervals of which accomplishments are true.[45] On the other hand, achievements are generally taken to be true of zero measure intervals, so condition (i) is trivially satisfied by them as the interval of which an achievement is true never has a proper subinterval. By condition (ii), non-eventive predicates can be true of zero measure intervals, and are also said to be temporally homogeneous (this is also known as the sub-interval property). Notice that, if not suitably restricted, condition (ii) only applies to stative predicates. Strictly speaking, activity predicates (e.g. *to run*) do not satisfy condition (ii), because of their granularity (for instance, it may be true of an (extended) interval v that John is running at v, though for some sub-intervals z of v it is not true that John is running at z, since z is too

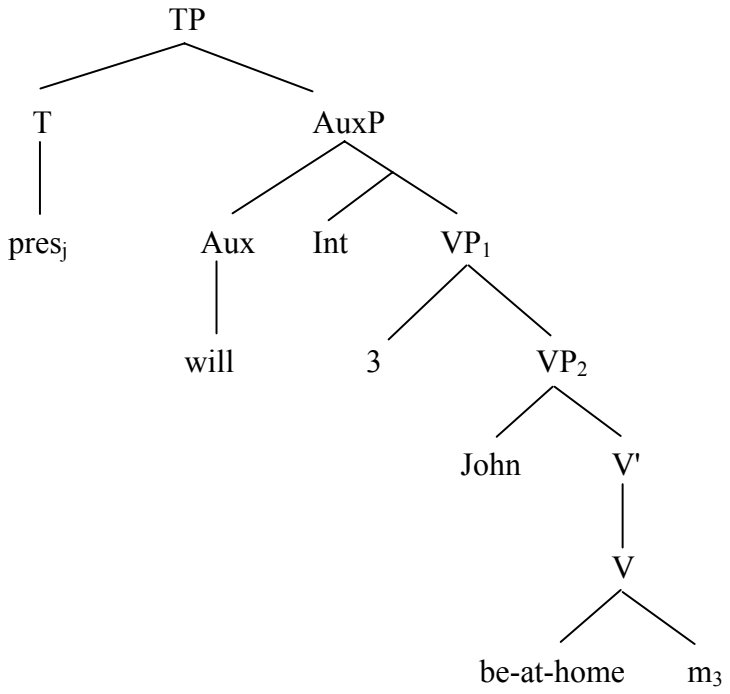
[44] The condition 'Init(z, v)' means that z is an initial sub-interval of v, and is formally defined as follows:
$\text{Init}(z, v) =_{def} z \subseteq v \wedge \forall u \in v\ \exists u' \in z\ u' \leq_U u$
[45] An articulated theory of accomplishments as complex events incorporating culminations has been recently proposed in Rothstein (2004).

small for any running event to occupy it – however short the event may be). Activity predicates do not satisfy condition (i) either. According to our classification, activities are thus neither eventive, nor non-eventive. This gap is not unintended, as activities pattern differently across different languages with respect to epistemic futures. In some languages of the Romance family (e.g., French) future sentences featuring bare activity predicates can be interpreted as epistemic futures (for instance, French *il dormira déjà* is acceptable with the meaning of *he will be already asleep now*), so in these languages activities seem to pattern like statives in this respect. In English, however, future sentences with bare activities cannot be interpreted as epistemic futures (e.g. English *he will already sleep* is not acceptable as epistemic future), wherefore one tends to conclude that activities travel with eventive predicates in English. For these reasons, we prefer to leave the issue of activities aside here, and to concentrate on the contrast between statives on the one hand and accomplishments/achievements on the other, which seems to us to be robustly preserved across languages.

Let's go back to our example (17a), repeated below.

(17) a. John will be at home.

Here, the eventuality of John being at home is intuitively related to the utterance time, i.e. (17a)'s temporal interpretation is present-oriented. How can we account for this feature of (17a)'s interpretation? First, consider the LF representation that is associated with (17a).



The denotation of AuxP (relative to context c, assignment g, and index *m*) is computed as follows:

$[\![VP_1]\!]^{c,g,m} = [\![3\ VP_2]\!]^{c,g,m}$

$= \lambda k.$ John is at home at $k \wedge k \subseteq M(m)$

$[\![Int\ VP_1]\!]^{c,g,m} = \lambda w.\ [\![VP_1]\!]^{c,g,w} = \lambda w.\ \lambda v.$[John is at home at $v \wedge v \subseteq M(w)$]

$[\![AuxP]\!]^{c,g,m} = [\![will]\!]^{c,g,m}([\![Int\ VP_1]\!]^{c,g,m})$

$= (\lambda \Pi.\ \lambda v$: Settled($\Pi$, i_v, $f(m,c)$). $\forall h \in f(m,c)\ \exists z \subseteq h\ [i_v <_l z \wedge \Pi(f(m,c))(z)])(\lambda w.\ \lambda v.$[John is at home at $v \wedge v \subseteq M(w)$])

$= \lambda v$: Settled($\lambda w.\ \lambda v.$[John is at home at $v \wedge v \subseteq M(w)$], i_v, $f(m,c)$). $\forall h \in f(m,c)\ \exists z \subseteq h\ [i_v <_l z \wedge$ John is at home at $z \wedge z \subseteq M(f(m,c))]$

By applying $[\![pres_k]\!]^{c,g,m}$ to $[\![AuxP]\!]^{c,g,m}$, we obtain the following truth-conditions (we assume that all the definedness conditions be satisfied):

$[\![TP]\!]^{c,g,m} = [\![pres_k]\!]^{c,g,m}([\![AuxP]\!]^{c,g,m})$

$= (\lambda P\text{: } g(k) = i_{tc}.\ \exists v\ [P(v) \wedge v \subseteq g(k) \cap M(m)])(\lambda v\text{: Settled}(\lambda w.\lambda v.[\text{John is at home at } v \wedge v \subseteq M(w)], i_v, f(m,c)).\ \forall h \in f(m,c)\ \exists z \sqsubseteq h\ [i_v <_I z \wedge \text{John is at home at } z \wedge z \subseteq M(f(m,c))])$

$= \exists v\ [(\lambda v\text{: Settled}(\lambda w.\ \lambda v.[\text{John is at home at } v \wedge v \subseteq M(w)], i_v, f(m,c)).\ \forall h \in f(m,c)\ \exists z \sqsubseteq h\ [i_v <_I z \wedge \text{John is at home at } z \wedge z \subseteq M(f(m,c))])(v) \wedge v \subseteq i_{tc} \cap M(m)]$

$= \exists v\ [\forall h \in f(m,c)\ \exists z \sqsubseteq h\ [i_v <_I z \wedge \text{John is at home at } z \wedge z \subseteq M(f(m,c))] \wedge v \subseteq i_{tc} \cap M(m)]$

$= \forall h \in f(m,c)\ \exists z \sqsubseteq h\ [i_{tc} <_I z \wedge \text{John is at home at } z \wedge z \subseteq M(f(m,c))]$

From the last formula we can infer that John being at home is predicated of an interval that completely follows the time of utterance. So, as far as we look at the semantics proper, there is no present-oriented feature in (17a)'s temporal interpretation. Our proposal is that the present-orientedness of (17a) is obtained via a pragmatic reasoning which is based on the maxim of relevance and also crucially exploits the homogeneity property of statives, expressed by condition (ii) above. We reconstruct the reasoning as follows.

Speaker *S* has uttered (17a) to convey some proposition about the present time (for instance, *S* might have uttered (17a) in reply to the question 'where is John?'). From a purely semantic perspective, however, the sentence used is about a future time, so, if the proposition *S* intended to convey were the one semantically expressed by the sentence, *S* would have violated the maxim of relevance. But *S* cannot have incurred in such a violation, as she is behaving in a cooperative way. The conclusion is that, although sentence (17a) semantically is about a future time, the proposition actually conveyed is about the present time. This temporal shift from a future time to the present is possible because the stative predicate 'to be at home' is homogeneous, and this is where semantics comes into play. The semantics of statives, crucially endowed with condition (ii), makes it possible that a unique continuous state of John being at home, stretching from the present up to some future time, be actually referred to by *S*, while the fact that *S* semantically refers to a subinterval of this state which lies to the future does not prevent the hearer from understanding *S* as actually intending to refer to a subinterval of the same state which lies at the present time. Thus, the proposition actually conveyed by *S* through her utterance can be represented by means of the truth-conditions given below, where z no longer is an interval lying to the future of the utterance time, but is rather cotemporal to the utterance time.

$[\![\ (17a)\ ]\!]^{c,g,m} = 1 \quad \textit{iff} \quad \forall h \in f(m,c)\ \exists z \sqsubseteq h\ [z \subseteq i_{tc} \wedge \text{John is at home at } z \wedge z \subseteq M(f(m,c))]$

We address now the issue of (17a)'s *modal* content. In order to derive the formula considered above, we had to assume that all the relevant definedness conditions were satisfied. In particular, we assumed that the settledness condition '*Settled*$(\lambda w.\ \lambda v.[\text{John is at home at } v \wedge v \subseteq M(w)], i_{tc}, f(m,c))$' was satisfied. However, considering the way we have defined $f(m,c)$ thus far, the latter assumption is trivial, as it turns out that whether John is at home now is settled in *every* possible context (settledness is certainly satisfied in this case: indeed, it will be always settled, for any eventuality *e* and utterance time *t*, whether *e* holds at *t* or not). Thus, our account will predict that (17a) is true just in those contexts in which John *is* at home now on every course of events which is contextually accessible, so that, if the set of courses of events contextually accessible is just a subset of the utterance world, the prediction reduces to saying that (17a) is true only in those contexts in which John is at home now. The question that we face now is how the meaning of (17a) can differ from the meaning of the plain indicative sentence (17c):

(17) c. John is at home.

Certainly a speaker that already had clear evidence for John being at home now would not use (17a) to convey the information that John is at home now, but she would rather use the plain indicative (17c). The point is that there is an intuitive difference between (17a)'s and (17c)'s meaning.

To deal with this issue, we follow Werner (2006) in assuming that modal sentences must make distinctions between worlds in their modal bases (this is Werner's *Disparity Principle*[46]). Thus far, the modal base for 'will' has been the set H_m of all histories that are objectively open at moment m (where m represents the world of evaluation), and 'will' has been taken to quantify over a subset $f(m,c) \subseteq H_m$ (i.e., the subset $H_m \cap X^*$ containing all the histories $h \in H_m$ that are compatible with the assumptions in X). We can then say that, for the cases considered thus far, 'will' has been taken to quantify over a "world-bounded" domain. Since the interpretation of the examples previously analyzed always involved a time in the future of the utterance time, we always had a future sentence like 'It will be the case that φ' evaluated on the background of multiple histories differing from each other with respect to whether φ is true at some time in the future or not. Indeed, all the previously considered examples were instances of future contingents, so it was always understood that among the objectively open futures there were some in which the relevant event occurs, and others where it does not. Of course, in each case the truth of the sentence required that settledness were satisfied, and that all the histories in the quantificational domain of 'will' behaved the same with respect to the instantiation of the relevant property; but in each case this was achieved by narrowing down the set of objectively open histories – the modal base – by means of the contextual assumptions. In the case of the epistemic future (17a), however, we have seen that the time about which the speaker is making her supposition is the present, and we know that the present (as well as the past) is definitely settled. This means that, if in the case of (17a) the domain of 'will' were "world-bounded" in the same way as in the previously considered cases, the sentence could not make the required distinction between worlds in its modal base, as all histories in this base would agree on whether the relevant property is instantiated or not. The only way for (17a) to satisfy the Disparity Principle is by being interpreted relative to an extended modal base, one that includes histories belonging to branching structures H_n that are distinct from the branching structure H_m corresponding to the actual world m. We note that the assumption that (17a) is interpreted relative to such a modal base is not a purely *ad hoc* stipulation, but is a natural assumption to make in view of the fact that a speaker who utters (17a) lacks knowledge about some facts that are already actual (in particular, the speaker doesn't know how things are with regard to John's present location in space). From the epistemic perspective of this speaker, it is perfectly natural to have a modal base including many worlds which differ from each other with respect to whether John is at home now. But in the BT framework adopted here, a modal base including worlds which differ from each other with respect to present or past facts is just a modal base including histories from different branching structures H_n. As before, the role of the contextual assumptions in determining the truth conditions of (17a) will be to filter out those histories from the modal base which do not conform to the assumptions themselves. Intuitively, in this case the set A_c will contain the speaker's assumption that John being at home now is a likely state of affairs in view of certain regularities regarding John's behaviour.

For the purpose of interpreting epistemic futures, we have to consider a further case of quantificational domain of 'will'. In order to deal with the new case, we introduce a function alt_s parameterized to the speaker s, such that, for any moment m, $alt_s(m)$ is the set of moments m' at which, for all s knows at m, s might be located (call this 'the set of epistemic alternatives for s at m'). Then, as quantificational domain of epistemic 'will', we consider the following value:

$$f(m,c) = \bigcup_{(m' \in alts(m))} (H_{m'} \cap X^*)$$

The proposal is then to make the union of all sets $(H_{m'} \cap X^*)$, for all m' that are epistemic alternatives for the speaker at m, and to take the resulting set as the quantificational domain of 'will' in the epistemic reading. We are now in a position to give a proper content to the abstract representation of (17a)'s truth-conditions, repeated below.

[46] For an illustration of this principle, consider the modal sentence 'John must be at home'. The constraint expressed by the Disparity Principle is that, in the modal base that we use to interpret this sentence, there must be both worlds where John is at home and worlds where John is not at home.

$[\![(17a)]\!]^{c,g,m} = 1$ *iff* $\forall h \in f(m,c)\ \exists z \subseteq h\ [z \subseteq i_{tc} \wedge$ John is at home at $z \wedge z \subseteq M(f(m,c))]$

What the right-hand formula says is that for every history compatible with the speaker's epistemic state and which is most conform to her assumptions, there is an interval cotemporal to the utterance time at which John is at home. In this way, the fine-tuned analysis captures both the temporal aspects (present-orientedness) and the modal aspects (epistemicity) of the interpretation of (17a).
Let's turn to sentence (17b) (repeated below), that we have seen not to be interpretable as an epistemic future. We want to show how the analysis predicts this impossibility.

(17) b. John will prove the theorem.

Without going through the whole derivation, assuming that all the relevant definedness conditions be satisfied, one obtains the following truth-conditions:

$[\![(17b)]\!]^{c,g,m} = 1$ *iff* $\exists v\ [\forall h \in f(m,c)\ \exists z \subseteq h\ [i_v <_I z \wedge$ John proves the theorem at $z \wedge z \subseteq M(f(m,c))] \wedge v \subseteq i_{tc} \cap M(m)]$

iff $\forall h \in f(m,c)\ \exists z \subseteq h\ [i_{tc} <_I z \wedge$ John proves the theorem at $z \wedge z \subseteq M(f(m,c))]$

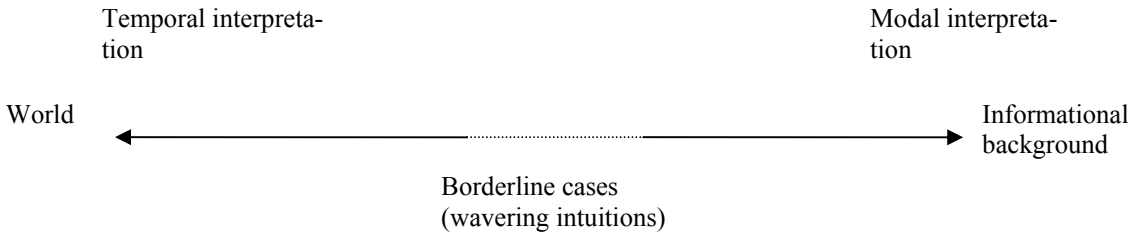
What the last formula says is that for every history which is compatible with the speaker's epistemic state and which is most conform to her assumptions, there is an interval z such that z completely follows the utterance time and John proves the theorem at z. From the temporal property of eventive predicates expressed by condition (i) above, it follows that the event referred to by the speaker cannot hold at any proper initial subinterval of z, in particular, it cannot stretch back to the utterance time. As a consequence, the sort of pragmatic reasoning that we have described above with regard to (17a) is not possible in this case, and we cannot understand the speaker as saying that the relevant event holds at the present time. This forces the reported event to lie in the future of the utterance time, hence the sentence cannot be interpreted as an epistemic future.
Epistemic futures are particularly interesting from our point of view, as they exploit the modal character of future sentences, thus providing convincing evidence for this modality. However, we have seen that the exploitation of this modality in epistemic futures undergoes severe constraints, which have to do with what actional type the verb has. For this reason, we understand that epistemic futures are a highly specific phenomenon, in which modality and actionality interact with each other in interesting ways.

8. Conclusions

Speaking of "future contingent statements", in the late Seventies McCall argued for the attractiveness of a semantics 'the model structures of which were dynamic rather than static'.[47] The proposal developed in this paper can be seen as an attempt to provide such a semantics, as we have presented a theory based on the temporal dynamics underlying the truth-evaluation of such statements. From this point of view, an aspect of our proposal that we think is worth emphasizing is the way the notion of utterance context is construed. We have shown that in the indeterministic perspective embodied by BT it is natural to assume a dynamic representation of a world as something which is sensitive to the time flow. We have thus observed that a principle of conservativity can be established, according to which an utterance event belonging to any world also belongs to a world that is

[47] See McCall (1979: 2): 'More interesting is the view that there is only one way to evaluate the truth or the falsehood of a future contingent statement, namely by waiting and seeing. This view does not require the existence of an ontologically distinguished future, but to elaborate it formally as a tense logic would require a semantics the model structures of which were dynamic rather than static. (At time *t* a given future-branching model structure would have a certain tree-like form; at time $t + \delta t$ it would have lost some branches and its main stem would be longer.)'
We propose to view our paper as an effort to formally develop the programmatic indication given by McCall.

temporally more evolved. Given such dynamic view, an utterance event, while being associated to a single time (the time of the utterance), turns out to be associated to many different worlds.
Our starting point has been the conviction that the intuitions underlying the modal interpretation (the SSR reading) and the temporal interpretation (the W&S reading) of the future tense, while apparently inconsistent with each other, are equally motivated by very common uses of future sentences. This is why the main goal of the paper has been to provide a *unified* semantic treatment for both families of interpretations.
On our proposal, the future auxiliary 'will' has been treated as a modal operator imposing a condition of settledness. Thus, if a future sentence S is uttered at u and its truth (falsehood) is *already* a settled issue at u *itself*, the sentence is true (false) at u, as required by the SSR reading. Otherwise, the sentence is neither true nor false at u and, to get a definite truth value, we must wait *until* settledness is reached in a different context, as required by the W&S reading.
In both cases, truth is determined by settledness with respect to the restricted world of the relevant context, and *the difference between the modal reading and the temporal reading is explained as a simple difference of context*, depending on the different distributions of the roles between the two main factors: the given state of information and the state of the world, respectively.



Ideally, this can be pictured as a scale: at one of the extremities we have the situations in which the world, as it will actually turn out to be at some *future* moment, has a prominent role to play; at the other extremity there are the situations in which the truth conditions are essentially determined by the reference to a *current* background of information. In between there are the situations in which the two main ingredients are deeply intertwined: typically these are the cases where our intuitions about the relevant truth conditions may be mostly wavering, due to the difficulty in discriminating between those factors.
Anyway, it is important to emphasize that the theoretical framework adopted here allows for a *unitary* treatment of two clear-cut cases, located at the opposite extremes of the scale. As a matter of fact, the time flow has no significant role to play in the case of an epistemic future like 'John will be at home now', because what determines the truth of the sentence, in *this* context, is the reference to a particular background of information, namely the speaker's conjectures about John's location. On the contrary, what is relevant for fixing the truth value of a sentence such as 'the die will come up six' (in the scenario described in section 1) is how things turn out to be at some future moment.

In general, the distribution of the roles between these factors (world and background of information) is a typical pragmatic issue which can be the object of accommodation processes. In some cases, it can even be submitted to an explicit *negotiation*, as witnessed by the following contrast:

(1) A: Leo will leave for Rome tomorrow.
B: No, he won't.

Consider first this possible continuation:

(2) A: I've just met him. This is his final decision.
B: All right. I didn't know.

In this case, B accepts to share the scenario presupposed by A, where what counts is Leo's decision. Yet, in a different situation, the same conversation might have a different conclusion:

(3) A: I've just met him. This is his final decision.
B: You're right. But there will be a strike which will prevent him from leaving. Anyway, let's wait and see.

Clearly, (2) and (3) illustrate different kinds of negotiation to fix the intended background. If, after (2), an agreement is reached, the truth conditions of A's original statement in (1) should be determined by referring to Leo's decision, i. e. by referring to evidence *now* available. On the contrary, in the case of (3), we must wait and see what will really happen. In general, the context is definite enough to determine which factor is most prominent, but in some cases there can be uncertainty, with an ensuing variability of intuitions.

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